

AD-A248 898



NUWC-NPT Technical Document 10,012
3 March 1992

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A Statistical Comparison of AUTECH and Eleuthera Island Wind Data for the Period 1 April 1989 Through 30 March 1990

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PREFACE

This study was conducted by the Range Management Division (Code 381) under AUTECH Job Order 696704.

REVIEWED AND APPROVED: 3 MARCH 1992

A handwritten signature in cursive script, appearing to read "Thomas J. Keegan".

**J. H. Keegan
Head, Test and Evaluation Department**

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 3 March 1992		3. REPORT TYPE AND DATES COVERED Final	
4. TITLE AND SUBTITLE A Statistical Comparison of AUTECH and Eleuthera Island Wind Data for the Period 1 April 1989 Through 30 March 1990				5. FUNDING NUMBERS	
6. AUTHOR(S) J. C. Park J. J. Hinkamp					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Undersea Warfare Center Detachment AUTECH West Palm Beach, FL 33402				8. PERFORMING ORGANIZATION REPORT NUMBER TD 10,012	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) This document presents a statistical comparison of wind data measured simultaneously on Eleuthera Island and at the Atlantic Undersea Test and Evaluation Center (AUTECH) on Andros Island, Bahamas, for the period 1 April 1989 through 30 March 1990. The statistics calculated and compared include empirical probability distributions, probability densities, conditional probability densities, cross-correlations, linear correlations, and power spectral estimates. The wind speed and direction data are found to be well correlated; however, the Eleuthera wind speed data exhibit a negative bias relative to the AUTECH data.					
14. SUBJECT TERMS Meteorology Wind Data Climatology Eleuthera Island Andros Island Bahamas				15. NUMBER OF PAGES 42	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT SAR		

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**A STATISTICAL COMPARISON OF AUTECH AND ELEUTHERA ISLAND WIND DATA
FOR THE PERIOD 1 APRIL 1989 THROUGH 30 MARCH 1990**

1. INTRODUCTION

This report compares averaged wind speed and direction data from the Atlantic Undersea Test and Evaluation Center (AUTECH) on Andros Island with similar data from Eleuthera Island. (Eleuthera, the site of a proposed tracking range, is some 100 miles east of Andros in the Atlantic Ocean.) Three data bases are used in the comparison; one was compiled at AUTECH Site 1 from 1 April 1989 through 31 December 1989; another was compiled at AUTECH Site 7 from 1 April 1989 through 30 March 1990; the third data base was collected at Eleuthera Island from 27 April 1989 through 30 March 1990. The 1989 wind data for AUTECH Sites 1 and 7 are reported in reference 1, and the data for Eleuthera are reported in reference 2. Reference 1 found a qualitative positive correlation for the AUTECH Site 1 and Site 7 data; this report extends the analysis to quantitative linear correlations and crosscorrelations. The AUTECH data are then correlated to the Eleuthera data in the same manner. In addition to temporal comparisons, relevant statistics are calculated for the AUTECH data to provide results parallel to the data presented in reference 2. The statistical interpretation allows for a conditional probability to be determined, thus allowing a predictive probability for Eleuthera winds based on AUTECH observations.

References 1 and 2 provide details on the measurement equipment and locations. Several pertinent differences existed in data measurement conditions. The AUTECH Site 1 and Site 7 anemometers were installed on offshore towers at a mean sea-level elevation of 10 meters, with no obstructions; the Eleuthera anemometer was installed approximately 1000 feet inland, at an elevation of 37 meters, and was partially obstructed to the northeast by a line of Australian pine trees several hundred feet away. The AUTECH data were recorded on analog stripchart recorders, and then read by an operator who "eyeball averaged" the data over 1-hour intervals. The Eleuthera data were electronically scanned and stored in real time in a digital random access memory (RAM) at the measurement site; the data were averaged via a pulsed bridge system over a 10-minute period, providing six observations per hour.

Because the AUTECH data were available in hourly averages, the Eleuthera data were similarly prepared. An hourly average was computed from three observations on either side of the hour; e.g., for the 1000 hours average, the six observations at 0935, 0945, 0955, 1005, 1015, 1025 were averaged. The wind direction data were vector averaged into hourly points, using the same six-observations-per-hour format as for the wind speed. The raw bearing was converted to sine and cosine components; the components were averaged arithmetically and then recombined for the direction estimate.

2. DATA PRESENTATION

The AUTECH data are examined first, so as to provide a basis for comparing either the Site 1 or Site 7 data with the Eleuthera data. Statistics similar to those described in reference 2 are developed for the AUTECH data.

Because the three data bases span different time periods, and because data gaps were introduced from hardware intermittency, care was taken to perform calculations on data sets that corresponded to equivalent time periods. Throughout this analysis, equivalent data sets were extracted from the overall data bases so that comparative statistics were calculated on sets for which simultaneous and contiguous data were available.

2.1 SITE 1 VS SITE 7 HOURLY AVERAGED WIND DATA

Figures 1 and 2, respectively, plot the AUTECH Site 1 and Site 7 hourly averaged wind speed data bases. Day 0 corresponds to 1 April 1989. Figures 3 and 4 plot the corresponding wind direction data for Sites 1 and 7, respectively. It is difficult to make any meaningful comparisons from direct inspection of these figures; however, data agreement in a broad sense is easily confirmed. The wind speed and direction information are condensed into histograms for Sites 1 and 7, respectively, in figures 5 and 6. The bulk of the wind observations are seen to come from directions of 30° to 180° true bearing, with dominant contributions from the east and southeast. Hourly average wind speeds of 20 knots or higher are rare.

2.1.1 Probability Distribution and Density

The set of hourly samples can be used to determine an overall probability distribution of observed wind speeds and directions. Because no *a priori* knowledge of the probability density function is assumed, the distribution function is termed an empirical probability distribution and is determined from

$$F_X(x') = P[X \leq x'], \quad -\infty < x' < \infty,$$

or the probability that the random variable of average wind speed x takes on a value in the set $(-\infty, x']$, where x' is a particular value of wind speed. This calculation was performed on the average wind speed samples depicted in figures 1 and 2 with values of x' at 1-knot intervals. The resulting empirical distribution functions are presented in figure 7. The distributions are seen to be nearly identical; in particular, 5 knots or less was observed 10 percent of the time and 15 knots or less was observed about 82 percent of the time. The median, or the value of the random variable in the middle of the distribution, is slightly less than 11 knots for Site 1 and 11.5 knots for Site 7.

Knowledge of the empirical probability distribution function provides a basis for computation of a probability density through the well-known integral relationship. The method employed was to model the calculated empirical distribution function as a Chebyshev approximation of order $n = 40$. Once the Chebyshev coefficients were determined for the modeled distribution function, it was a straightforward process to obtain the Chebyshev coefficients for the derivative of the function. The Chebyshev polynomial was then evaluated for the derivative of the function at 1-knot intervals. To provide a continuous function for the initial Chebyshev approximation, the distribution function was first interpolated by a cubic spline. Evaluation of the Chebyshev coefficients revealed that the first 9 terms were sufficient; thus, the remaining 31 terms were discarded.

Figure 8 presents the calculated probability densities for Sites 1 and 7. The two probability functions are nearly identical; the only discernible difference is a 1-knot bias, with Site 7 exhibiting a mode (value of the random variable with the largest probability) of 11 knots and a Site 1 exhibiting a mode of 10 knots. As detailed in reference 2, a gamma distribution

$$f_x(x) = \frac{\lambda(\lambda x)^{\alpha-1} e^{-\lambda x}}{\Gamma(\alpha)}$$

can be fit to the data to provide first and second moment estimators.

Hourly averaged directional data were also employed for calculation of probability distribution and density functions. Figure 9 shows the Site 1 and Site 7 directional empirical distribution functions. Figure 10 plots the Site 1 and Site 7 calculated probability densities. The two distributions exhibit close resemblance and confirm the east-southeast wind direction as predominant.

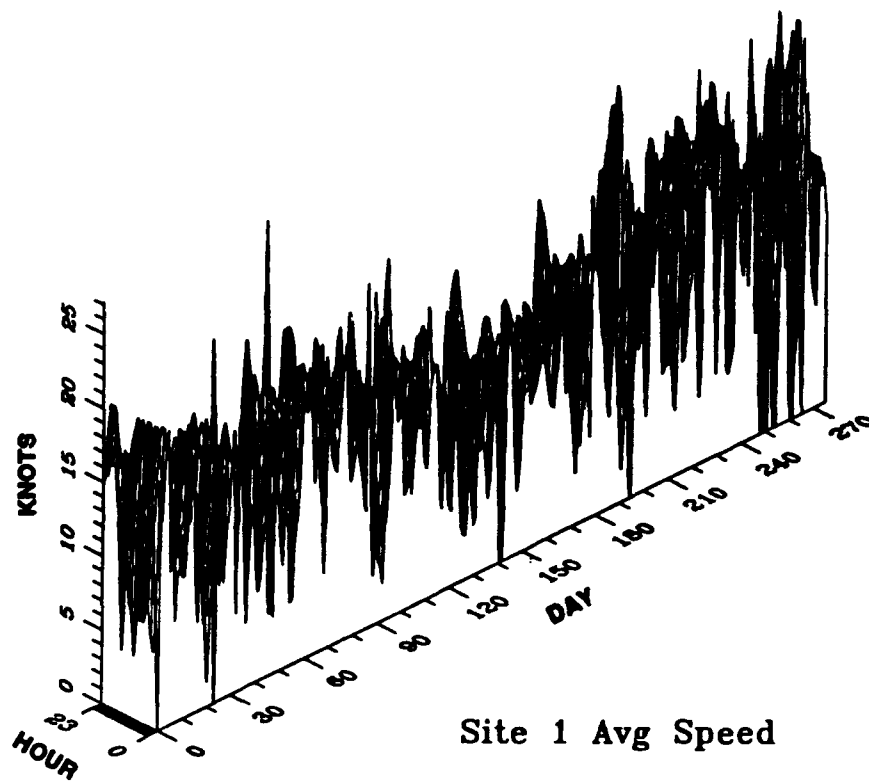


Figure 1. Site 1 Average Speed

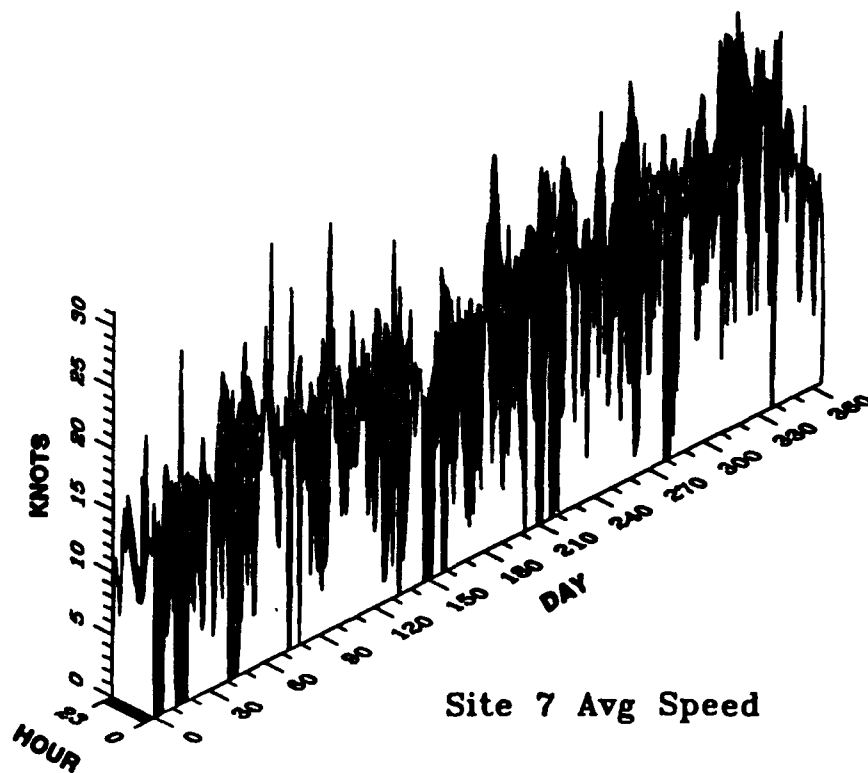


Figure 2. Site 7 Average Speed

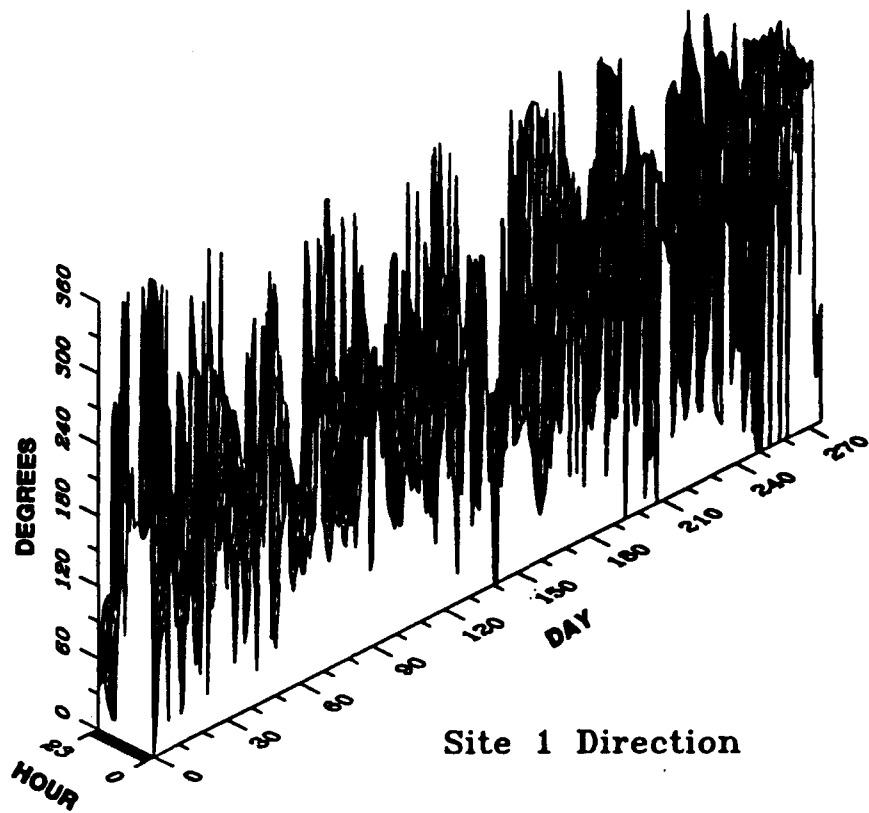


Figure 3. Site 1 Average Direction

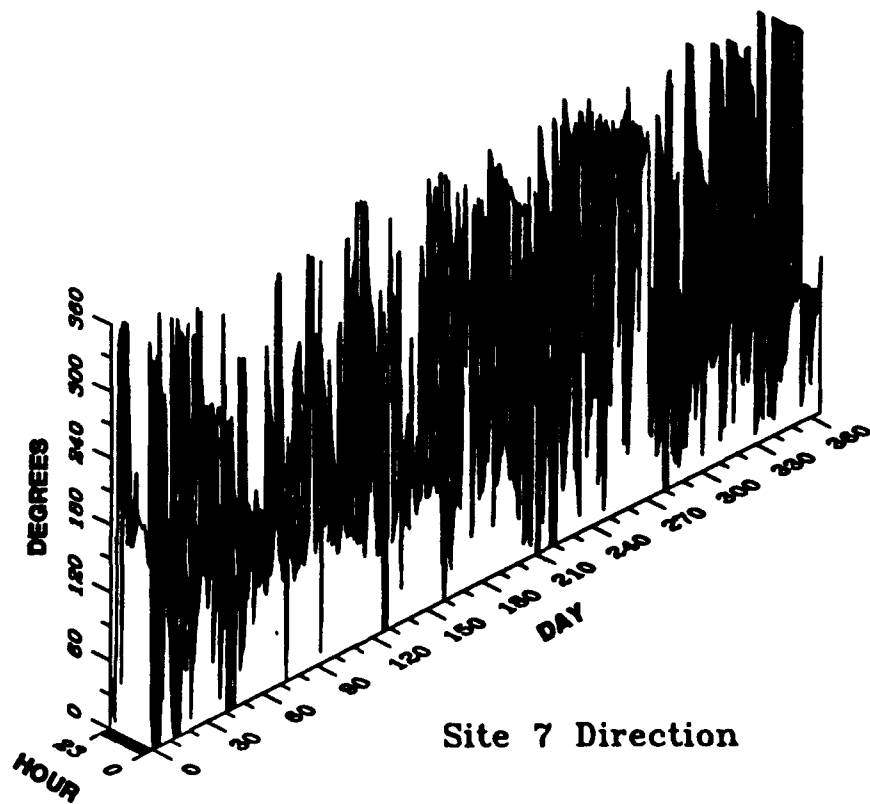


Figure 4. Site 7 Average Direction

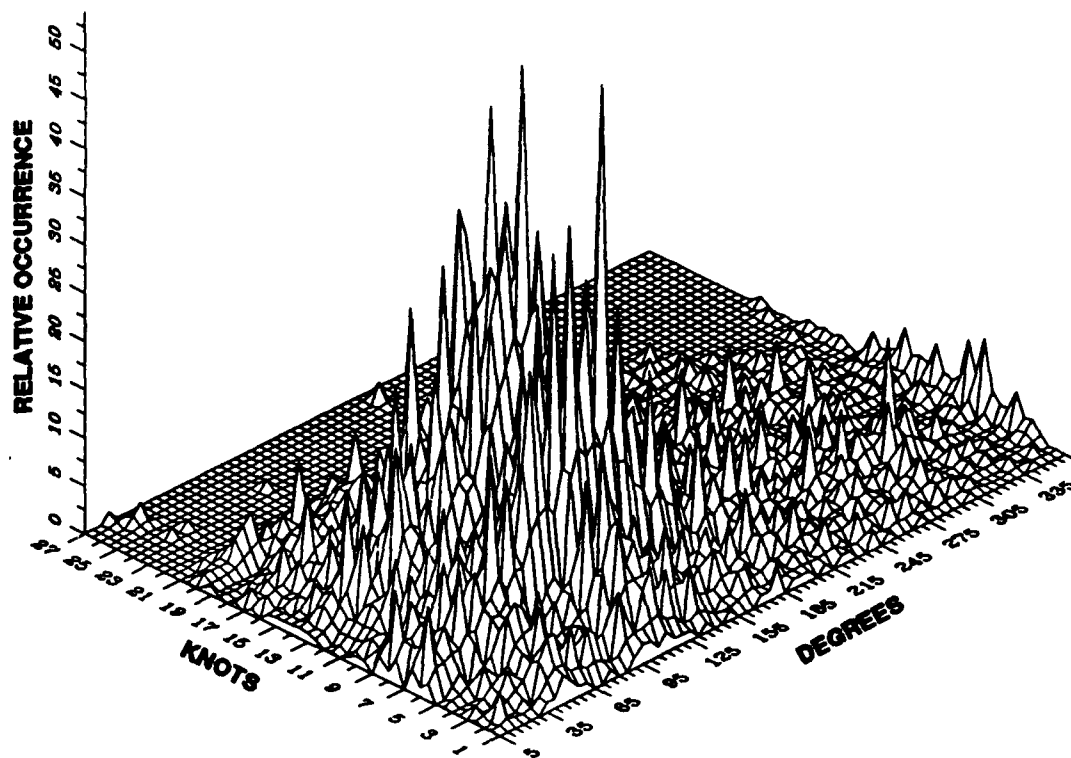


Figure 5. Site 1 Speed vs Direction

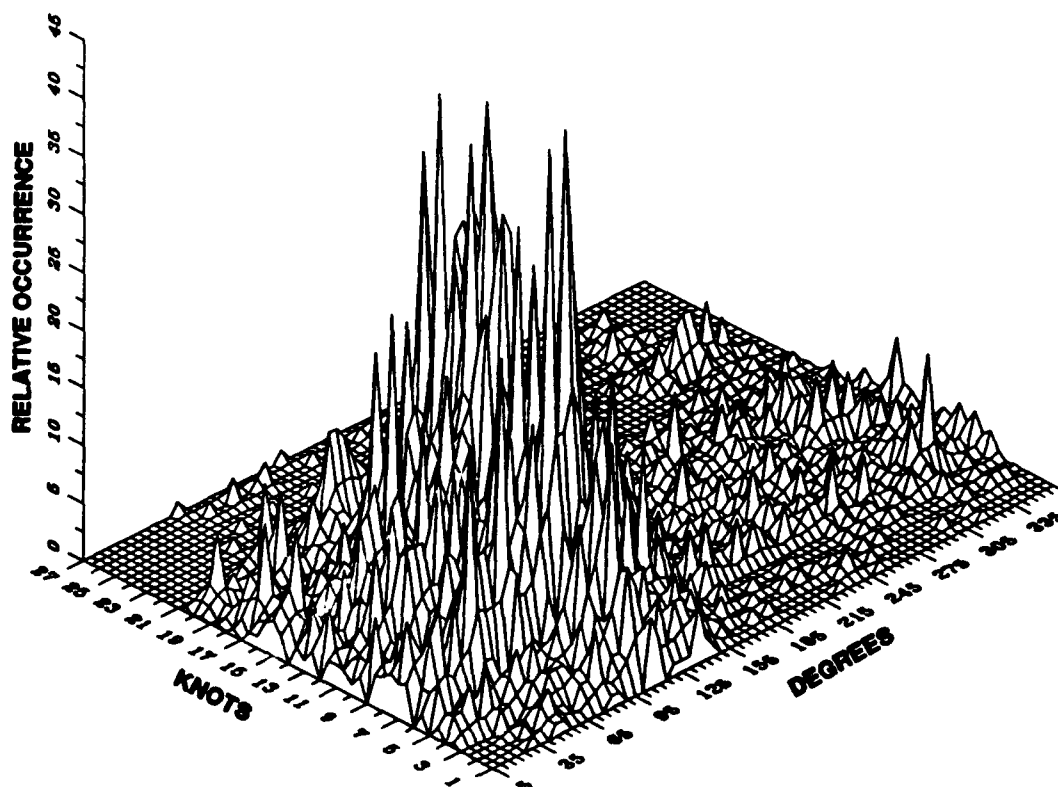


Figure 6. Site 7 Speed vs Direction

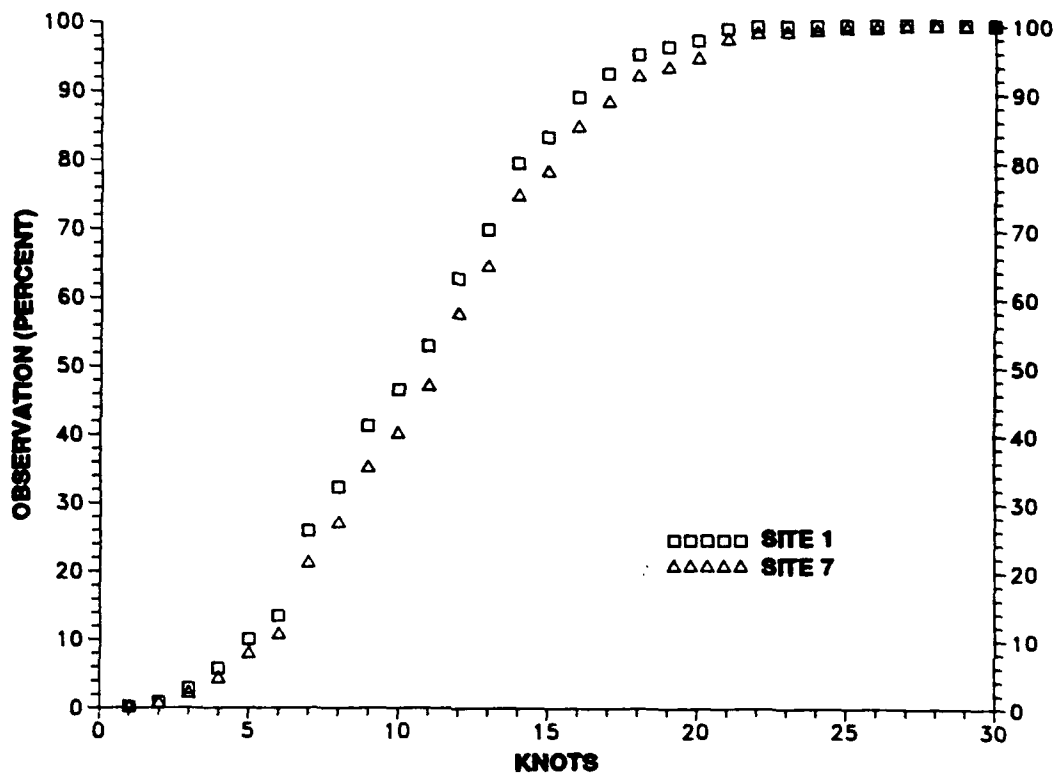


Figure 7. Site 1 and Site 7 Average Speed Empirical Distribution

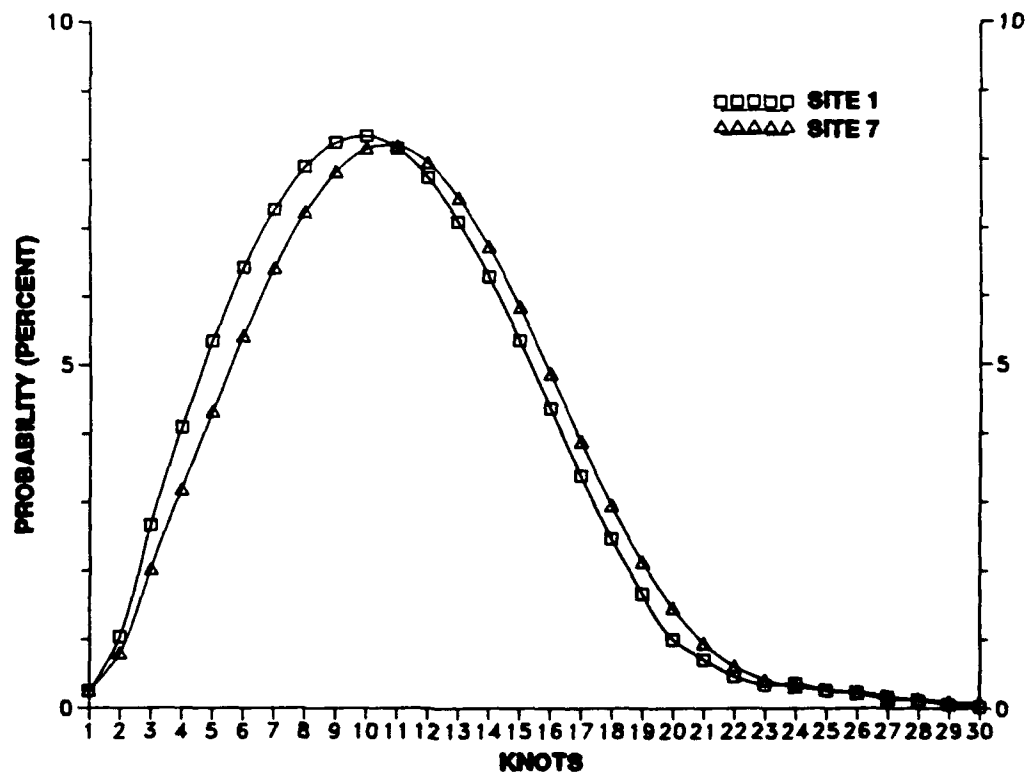


Figure 8. Site 1 and Site 7 Average Speed Probability Density

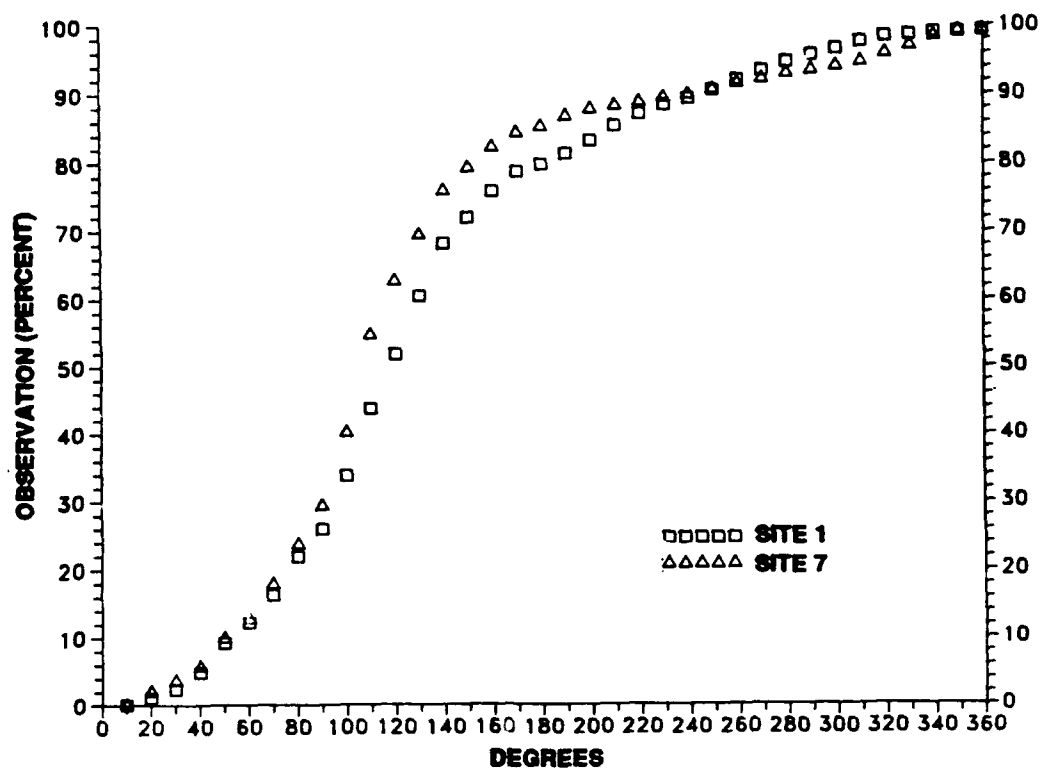


Figure 9. Site 1 and Site 7 Direction Empirical Distribution

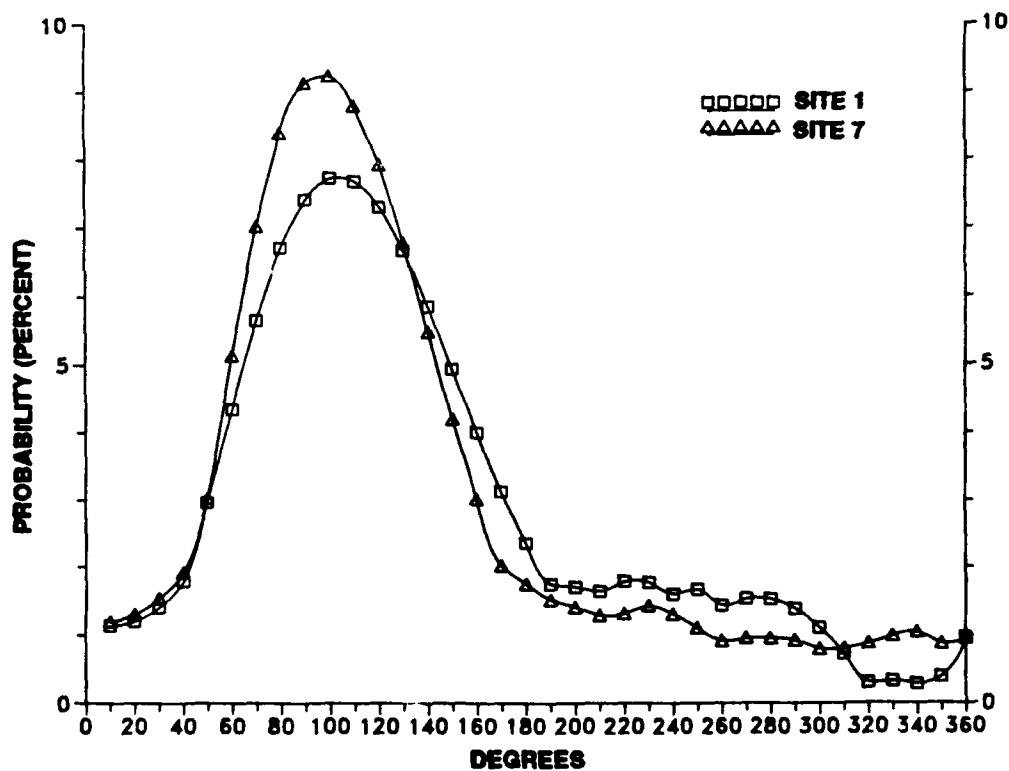


Figure 10. Site 1 and Site 7 Direction Probability Density

2.1.2 Conditional Probability Distribution and Density

In addition to the independent probability distribution, a conditional probability may be defined by replacing the probability of the empirical distribution by a conditional probability. That is, the empirical distribution is replaced by the conditional empirical distribution:

$$F_B(b|A) = \frac{P[(B \leq b) \cap A]}{P[A]} .$$

This addresses the question: Given the occurrence of event A, what now is the probability of event B taking a value in the set $(-\infty, b]$? This calculation assumes that $P[A] > 0$; the denominator simply renormalizes the probability of events that occur jointly with A. If event A is specified as the measured value of an hourly averaged wind speed at Site 1, and event B as the next hourly value of wind speed at Site 1, then calculation of the conditional probability distribution results in the data shown in figure 11.

The conditional probability density is calculated as

$$f_B(b|A) = \frac{d}{db} F_B(b|A) ,$$

with the same numerical procedure outlined for the independent probability densities. The resulting conditional probability densities for the Site 1 wind data are presented in figure 12, which is to be interpreted as follows: Given that the wind speed of A has been recorded at Site 1, what is the probability distribution of wind speed B next to occur at Site 1? Note the essentially symmetric distribution of conditional wind speed probability with measured wind speed.

2.1.3 Power Spectral Density

The hourly wind speed averages were used to calculate a wind speed power spectral density (PSD) by standard methods. The data were partitioned into blocks of 256 points, tapered with a Welch window, and processed with a 50-percent overlap. This allowed for 20 averages to be used in the power spectral estimate. The result is shown in figure 13 for the Site 1 and Site 7 data. A common spectral component for Site 1 and Site 7 is seen at 46×10^{-6} Hz or 6.0 hours. The other notable feature of the PSDs is that there are no large harmonic contributions; spectral components are seen to vary only within 2-3 dB and indicate an essentially "bandpass" process.

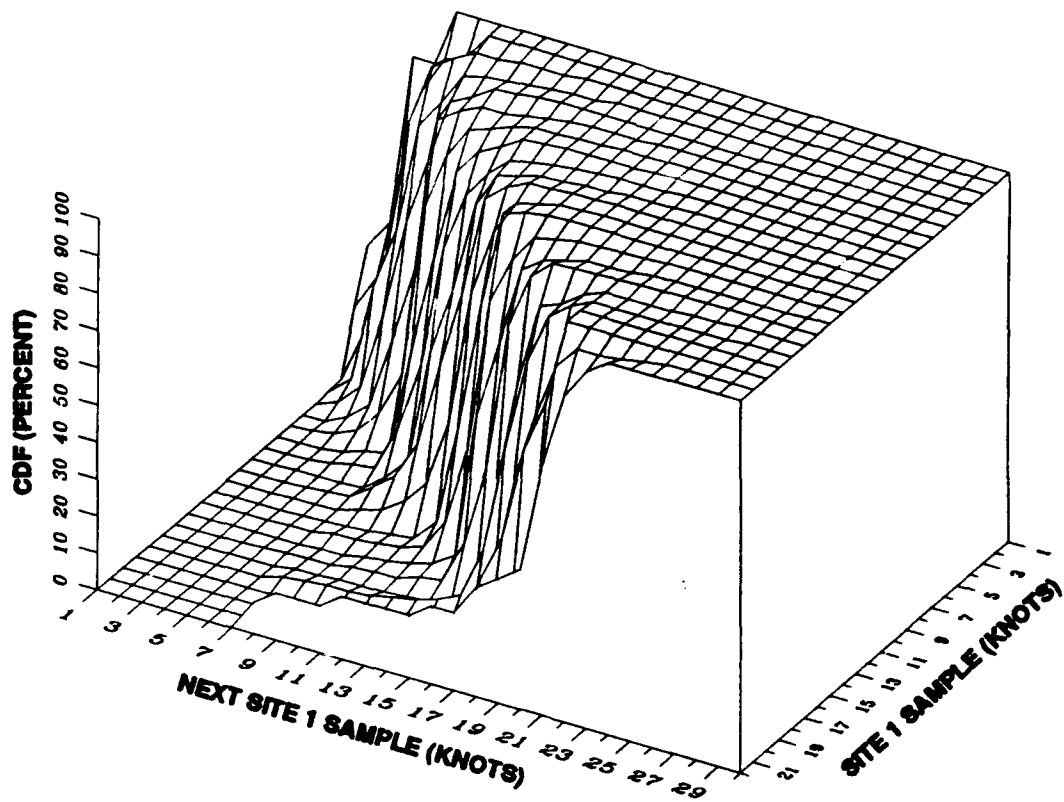


Figure 11. Site 1 Average Speed Conditional Probability Distribution

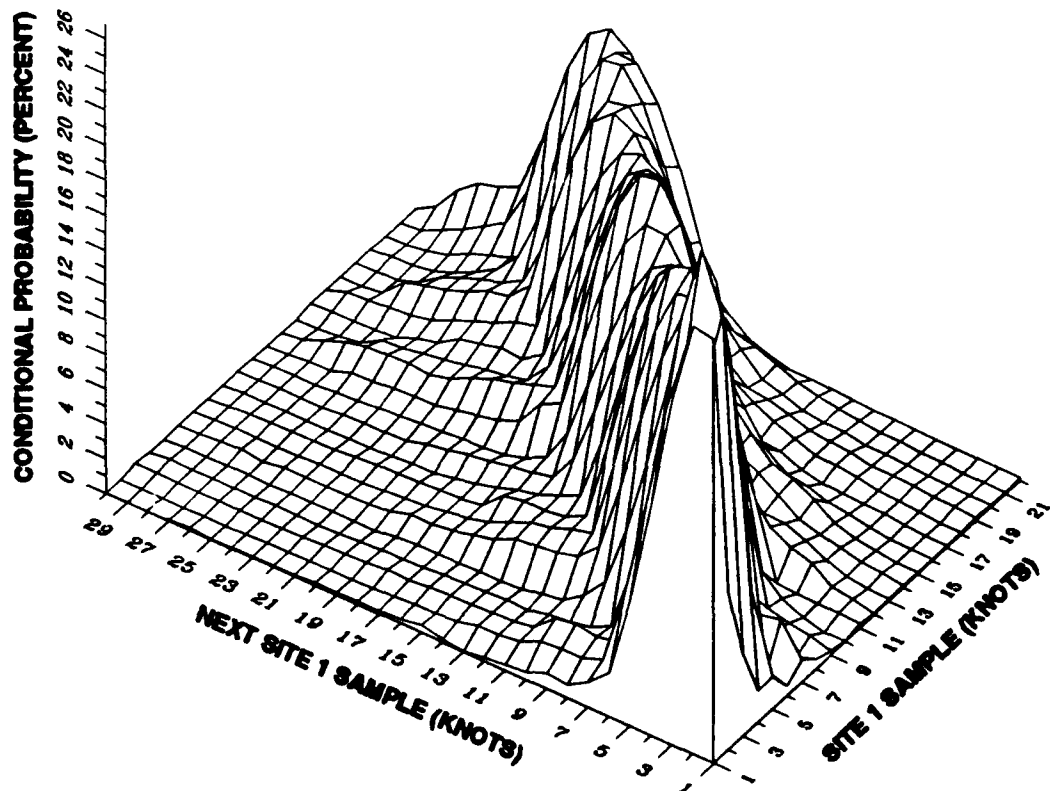


Figure 12. Site 1 Average Speed Conditional Probability Density

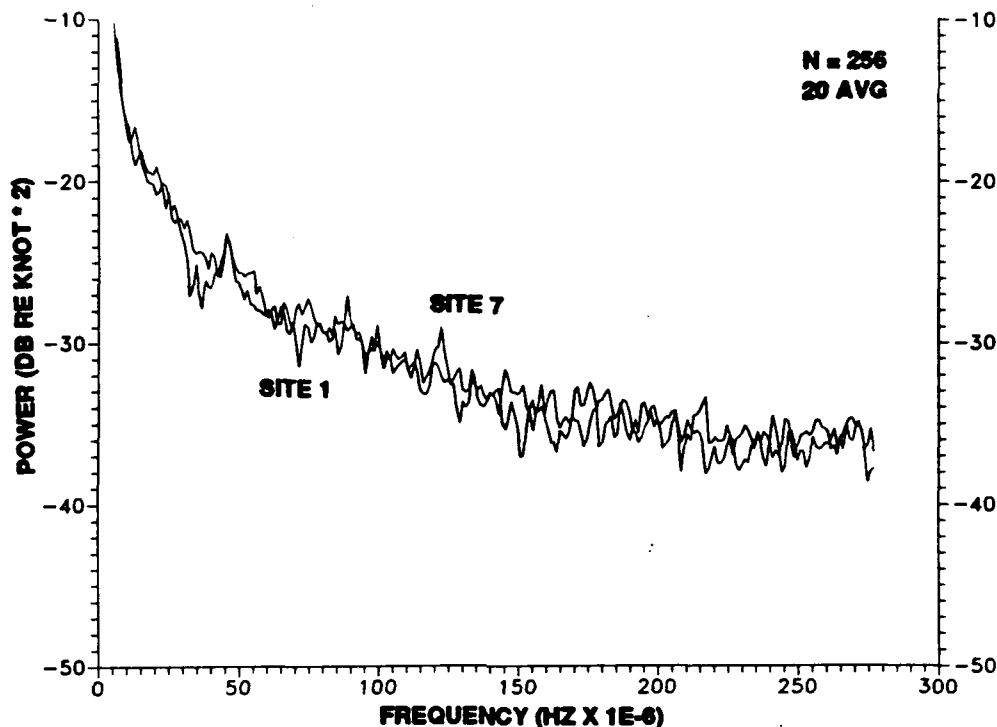


Figure 13. Site 1 and Site 7 Power Spectrum

2.1.4 Crosscorrelation

The cross correlation of two signals is defined as

$$R_{xy}(t) = \int_{-\infty}^{\infty} x(t + \tau)y(\tau)d\tau ,$$

where the value of t represents some value of time lag between the signals. If the two signals are close copies of each other for a given value of t , then the crosscorrelation will have a large value for that particular t . In this study, the correlation integral was not evaluated explicitly; instead, the crosscorrelation was computed via the well-known spectral relationship

$$R_{xy}(t) = F^{-1}[x(\omega)y(\omega)^*]$$

or as the inverse Fourier transform of the cross-spectral density. The crosscorrelation for the Site 1 and Site 7 hourly averaged wind speed and direction is shown in figure 14 for time lags up to 72 hours. This plot clearly indicates that the Site 1 and Site 7 data are well correlated at zero lag time; i.e., the real-time Site 1 and Site 7 data are similar replicas of each other when considered as hourly averages.

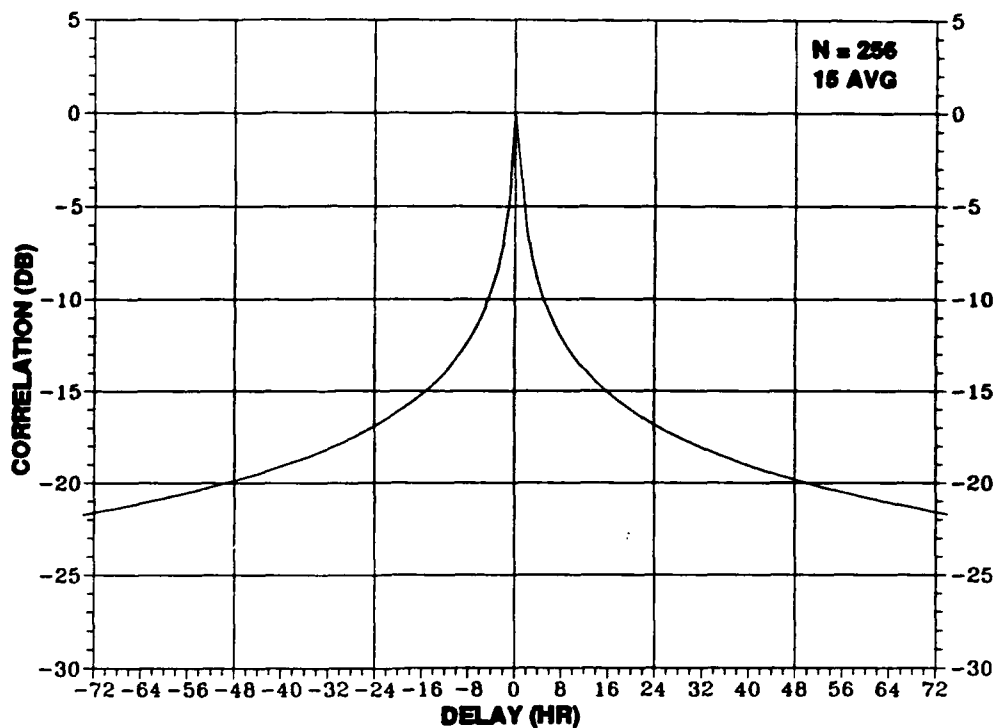


Figure 14. Site 1 and Site 7 Crosscorrelation

2.1.5 Linear Correlation

While the crosscorrelation provides information about whether or not two signals are correlated, it does not say anything about the strength of the correlation between them. For that measure, the linear correlation coefficient can be invoked:

$$r = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2} \sqrt{\sum_i (y_i - \bar{y})^2}}$$

where the bar denotes the mean. The value of r is 1 when the data points lie on a straight line with positive slope; this is termed "complete positive correlation." For the linear correlation calculation, the data were divided into contiguous blocks for which the Site 1 and Site 7 data were simultaneously valid. The positive linear correlations for a 4-hour and 12-hour block size for the Site 1 and Site 7 average wind speed are shown in figure 15. The 12-hour data blocks have r -values from 0.5 to 0.95, while the 4-hour blocks have correlation values ranging from 0.9 to 1. The increase in linear correlation with decreasing block size indicates that the data are well correlated in the real-time sense. Figure 16 presents the linear correlations for the Site 1 and Site 7 wind direction data.

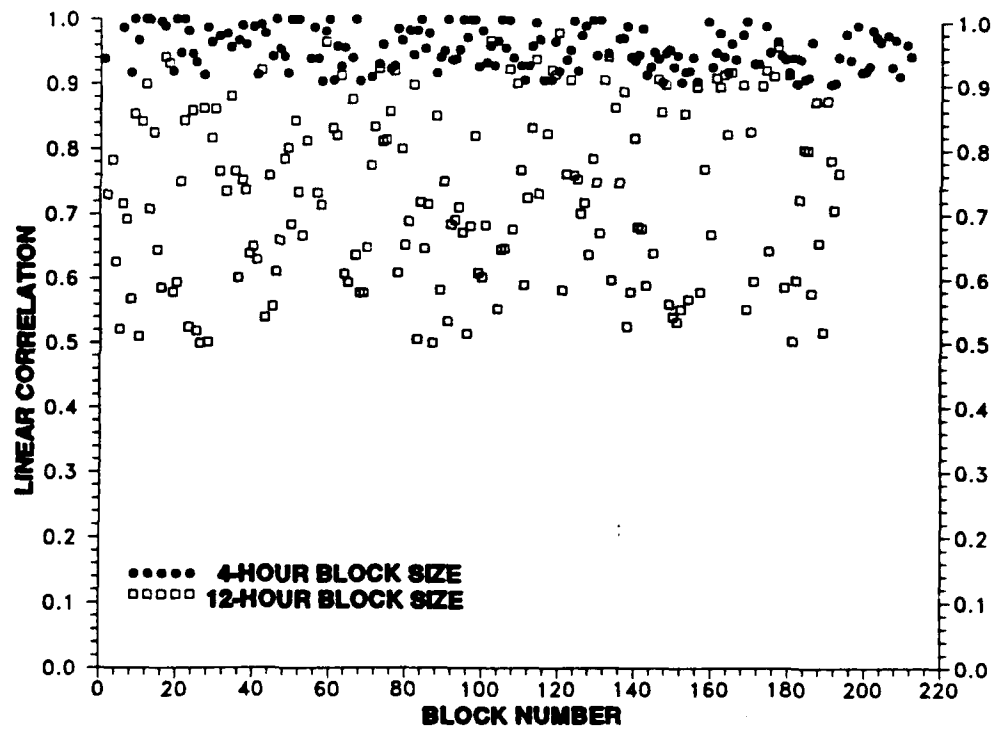


Figure 15. Site 1 and Site 7 Average Speed Linear Correlation

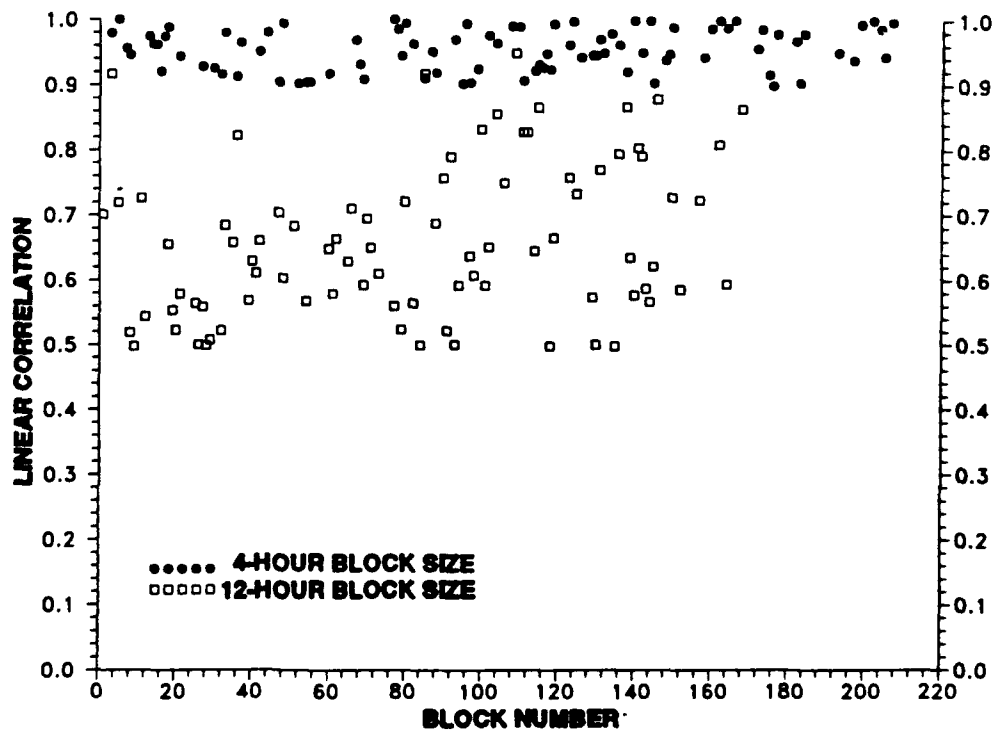


Figure 16. Site 1 and Site 7 Direction Linear Correlation

2.1.6 Cross-Spectral Density

The cross-spectral density (CSD) is defined as the Fourier transform of the crosscorrelation. The CSD preserves the relative phase information of the two signals and provides a basis for a transfer function calculation. The CSD can also be found from the individual Fourier spectra as

$$S_{xy}(\omega) = S_x^*(\omega)S_y(\omega),$$

where * indicates the complex conjugate. The data were partitioned into blocks of 256 points, tapered with a Welch window, and processed with a 50-percent overlap, resulting in 15 averages. The log-magnitude CSD for the Site 1 and Site 7 wind speed and direction is shown in figure 17. The cross-spectra exhibit essentially the same "bandpass" nature as the individual spectra; this is not surprising given the form of the crosscorrelation (figure 14) and the individual spectra (figure 13).

2.1.7 Transfer Function

The transfer function (or frequency response) for a linear system is defined as the ratio of the output to the input as a function of frequency. If the input is taken as a wind speed measurement at Site 1 and the output as a wind speed measurement at Site 7, and if the so defined "system" is linear, then knowledge of the transfer function provides a predictive capability for Site 7 wind spectra based on Site 1 measurements. The transfer function is calculated as

$$H_{xy}(\omega) = \frac{S_{xy}(\omega)}{S_{xx}(\omega)},$$

and the log-magnitude for the Site 1 and Site 7 input/output system is shown in figure 18. The positive zero frequency component is expected because the Site 7 data were seen to be biased slightly higher than the Site 1 data.

To characterize the utility of the transfer function in specifying input/output relations for the assumed linear "system," the coherence must be examined; the coherence measure is addressed in section 2.1.8.

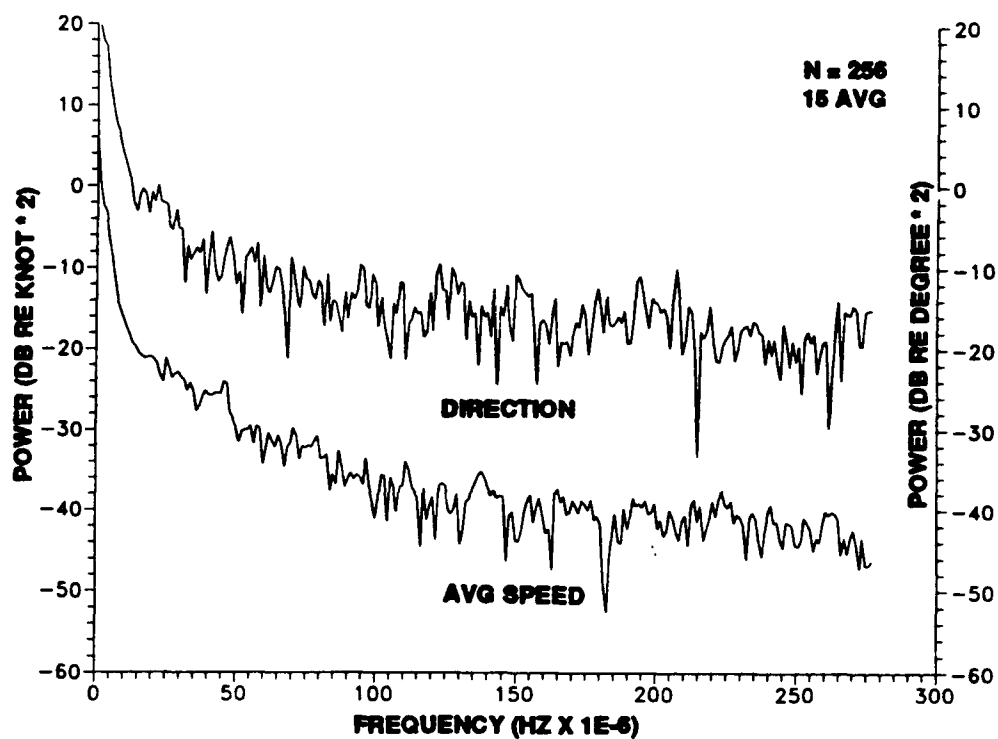


Figure 17. Site 1 and Site 7 Cross-Spectral Density

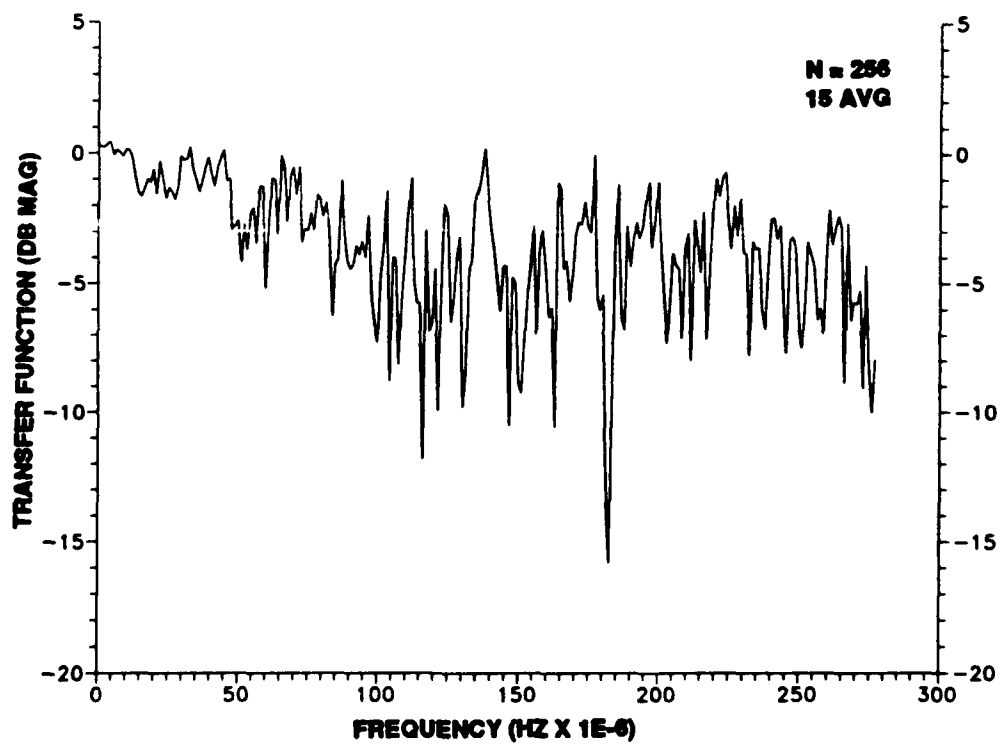


Figure 18. Site 1 and Site 7 Average Speed Transfer

2.1.8 Coherence

Coherence is a measure of the causality of the assumed system over the averaging process and is computed as

$$\gamma_{xy} = \sqrt{\frac{|S_{xy}(\omega)|^2}{S_{xx}(\omega)S_{yy}(\omega)}}$$

A value of 1 for the coherence indicates that the transfer function assumption of pure causality between output and input is satisfied. Figure 19 plots the coherence calculated for the Site 1 and Site 7 average wind speed. As is seen, the coherence is less than 0.4 for frequencies above 45×10^{-6} Hz (6 hours) and is near unity only for frequencies near zero. These results indicate that the near-zero frequency components are the only ones amenable to prediction based on linear transfer function methods. In other words, the influence of random noise is a factor in the direct comparison of Site 1 and Site 7, except for very long time periods (low frequencies) where the noise fluctuations are not contributing.

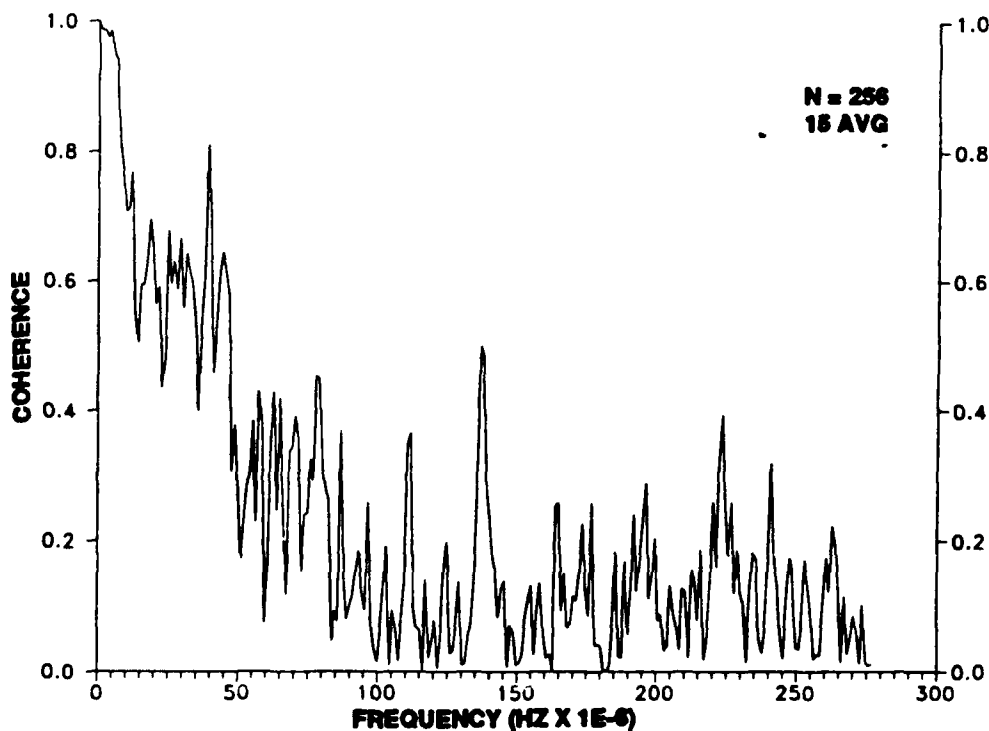


Figure 19. Site 1 and Site 7 Average Speed Coherence

2.2 SITE 1 VS SITE 7 DAILY AVERAGED WIND DATA

In addition to the hourly averaged data, each data base was condensed into daily averages. Figure 20 plots the Site 1 and Site 7 daily averaged wind speeds. This plot serves mainly as an opportunity to check the validity of the results obtained thus far. The presence of a bias is confirmed, with Site 7 exhibiting slightly higher wind speeds, and mode values of 10 and 11 knots appear reasonable. As found in section 2.1.8, the relatively high coherence and small positive magnitude transfer function at the 11.6- μ Hz diurnal frequency support the Site 7 positive bias and the finding of well-correlated results. The sample deviations corresponding to the average data in figure 20 are shown in figure 21.

2.3 SITE 1 VS SITE 7 PER HOUR WIND DATA

To provide data compatible with the reference 2 data, each data base was also averaged over the entire data base for each hour of the day. Figure 22 shows the Site 1 and Site 7 per hour averaged data. The positive Site 7 bias is evident; however, the absence of a morning variation in the Site 7 data is unexpected. The sample deviations for the Site 1 and Site 7 per hour data are shown in figure 23.

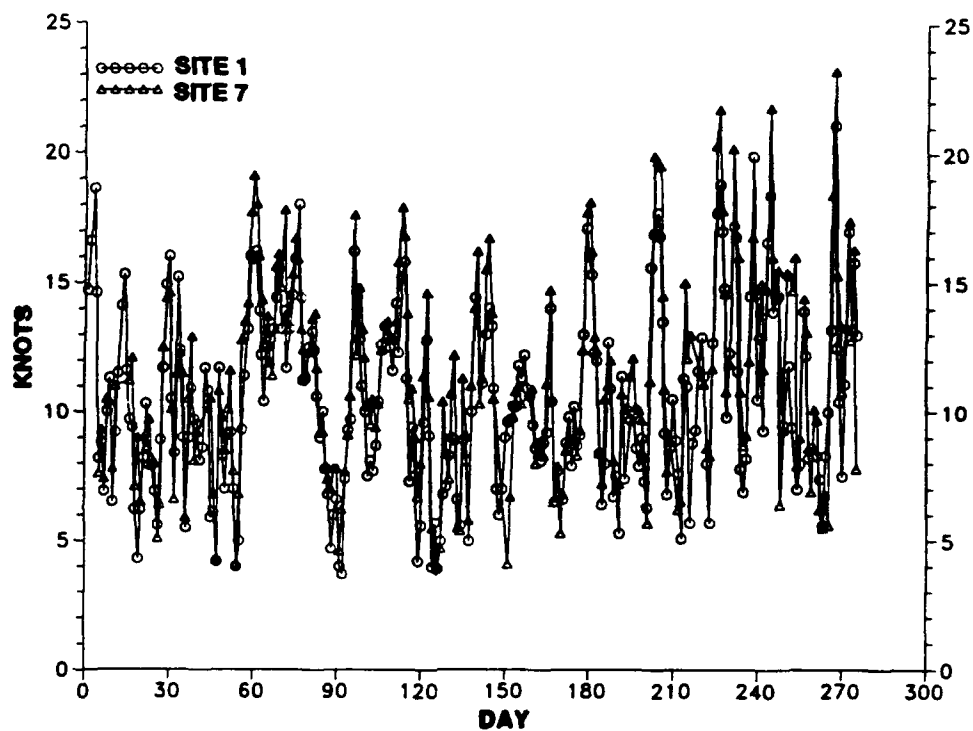


Figure 20. Site 1 and Site 7 Daily Averaged Speed

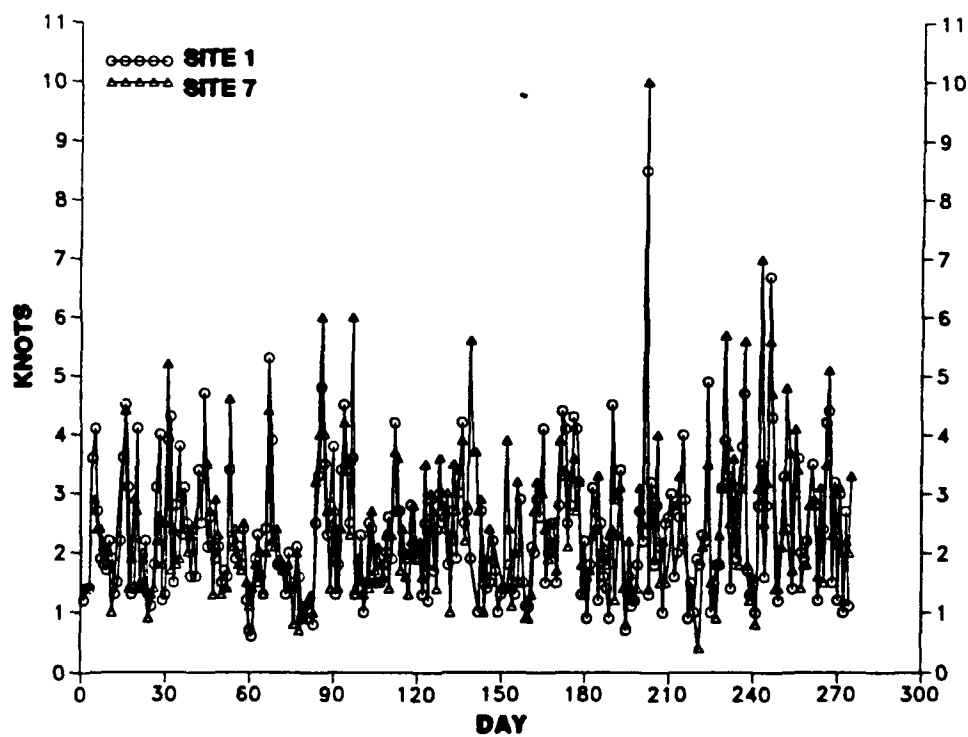


Figure 21. Site 1 and Site 7 Daily Speed Deviation

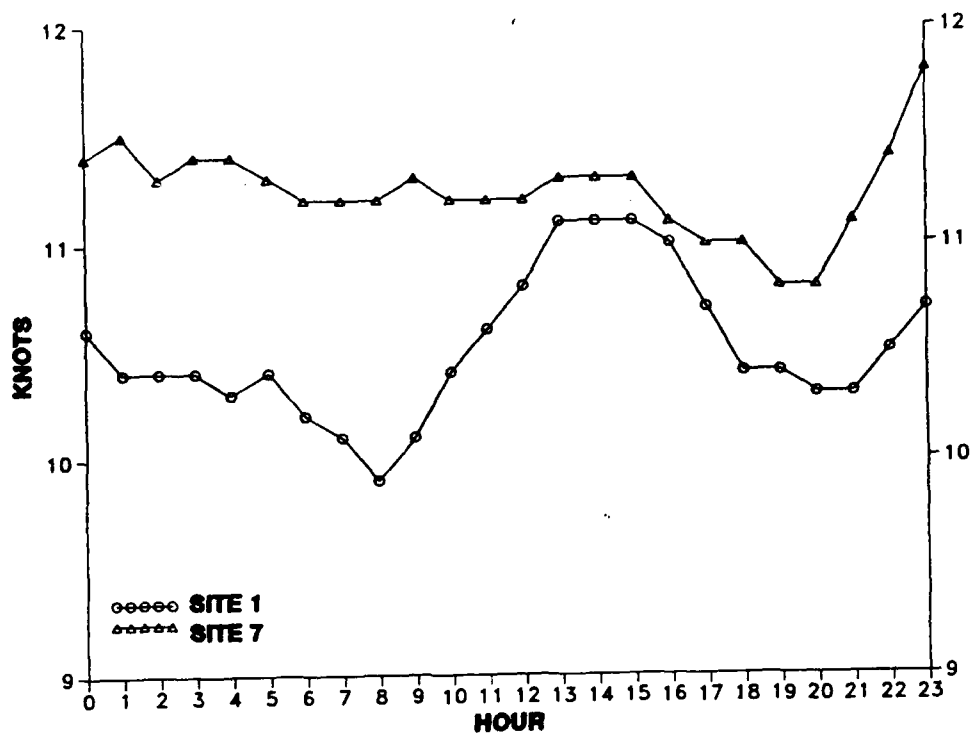


Figure 22. Site 1 and Site 7 Hourly Averaged Speed

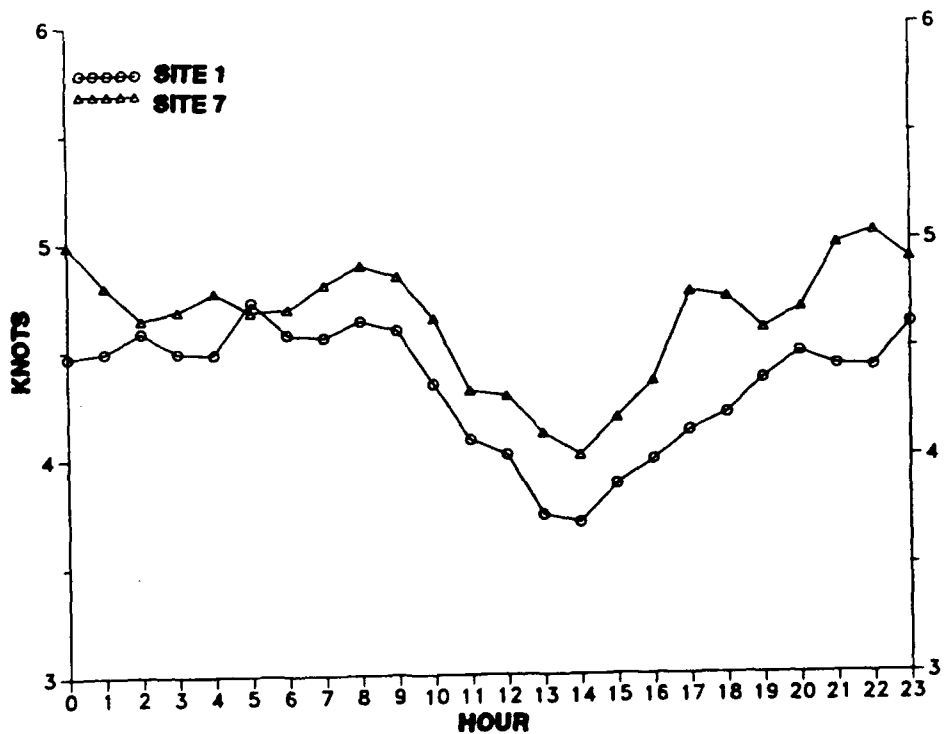


Figure 23. Site 1 and Site 7 Hourly Speed Deviation

2.4 SITE 1 VS ELEUTHERA HOURLY AVERAGED WIND DATA

This section compares the appropriate AUTECH Site 1 data with the data collected at Eleuthera (reference 2).

2.4.1 *Probability Distribution and Density*

Figure 24 shows the empirical distribution functions for the Site 1 and Eleuthera hourly averaged wind speed data. It indicates immediately that the Site 1 wind speeds are on average higher than the Eleuthera observations. In particular, the Site 1 median is near 10.5 knots, while the Eleuthera median is about 7.5 knots. Figure 25 plots the calculated probability densities for the Site 1 and Eleuthera hourly wind speeds. Again, striking evidence is seen that the two data sets are biased, with the Site 1 data exhibiting significant increased probability for wind speeds above 10 knots. The Site 1 mode is 10 knots, and the Eleuthera mode is 7 knots. These results were calculated from different data sets than those used in section 2.1 or reference 2, owing to differing periods of data availability; however, the similarity of these results to those previously obtained is expected.

Empirical distribution functions for the Site 1 and Eleuthera wind direction data are shown in figure 26. Much closer agreement is seen here than for the wind speed data. Figure 27 plots the corresponding calculated probability densities; the east and east-southeast directions are seen to be the most probable.

2.4.2 *Conditional Probability*

The conditional probability of hourly averaged wind speed at Eleuthera (event B), given a wind speed observation at Site 1 (event A), is plotted in figure 28. Note the asymmetric distribution of wind speed predicted at Eleuthera; that is, for the higher wind speed observations at Site 1 the predicted Eleuthera speed is considerably less than the value observed at Site 1. This result is in contrast to the Site 1 observations applied to the next hourly wind speed at Site 1, as was shown earlier in figure 11.

2.4.3 *Crosscorrelation*

The crosscorrelation for the Site 1 and Eleuthera wind speed and direction data is shown in figure 29. The result is essentially equivalent to the Site 1 and Site 7 correlation for zero lag time.

2.4.4 *Linear Correlation*

Figures 30 and 31 present the linear correlation coefficients for the Site 1 and Eleuthera averaged wind speed and direction data, respectively. The calculations are shown for 4-hour and 12-hour data blocks, with results similar to those obtained for the Site 1 and Site 7 comparison.

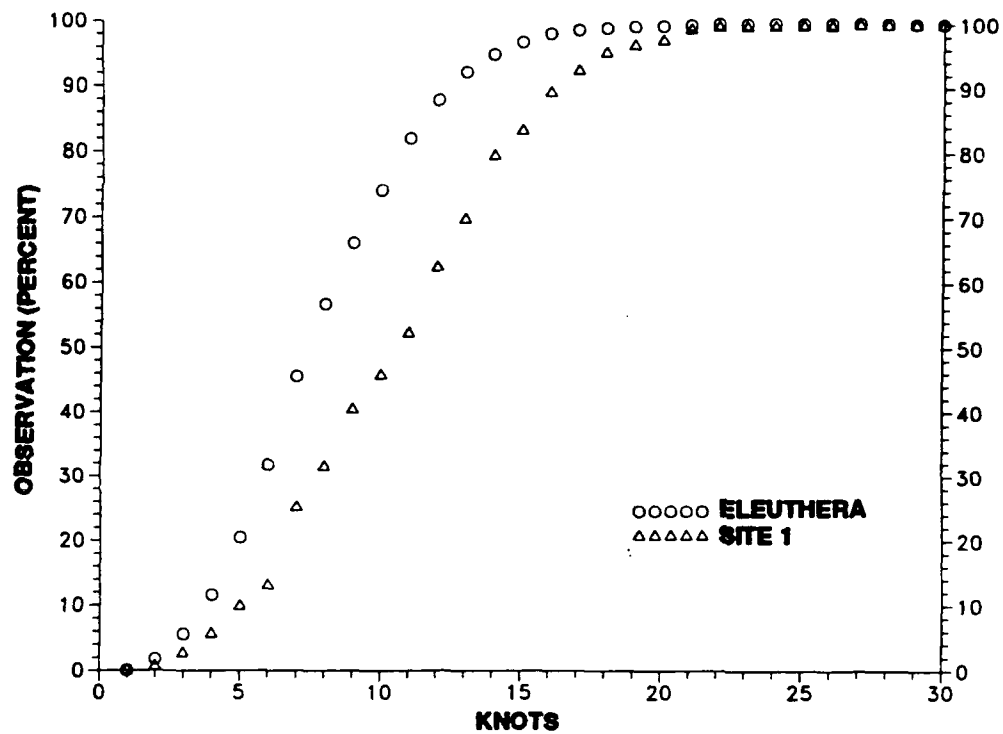


Figure 24. Eleuthera and Site 1 Speed Empirical Distribution

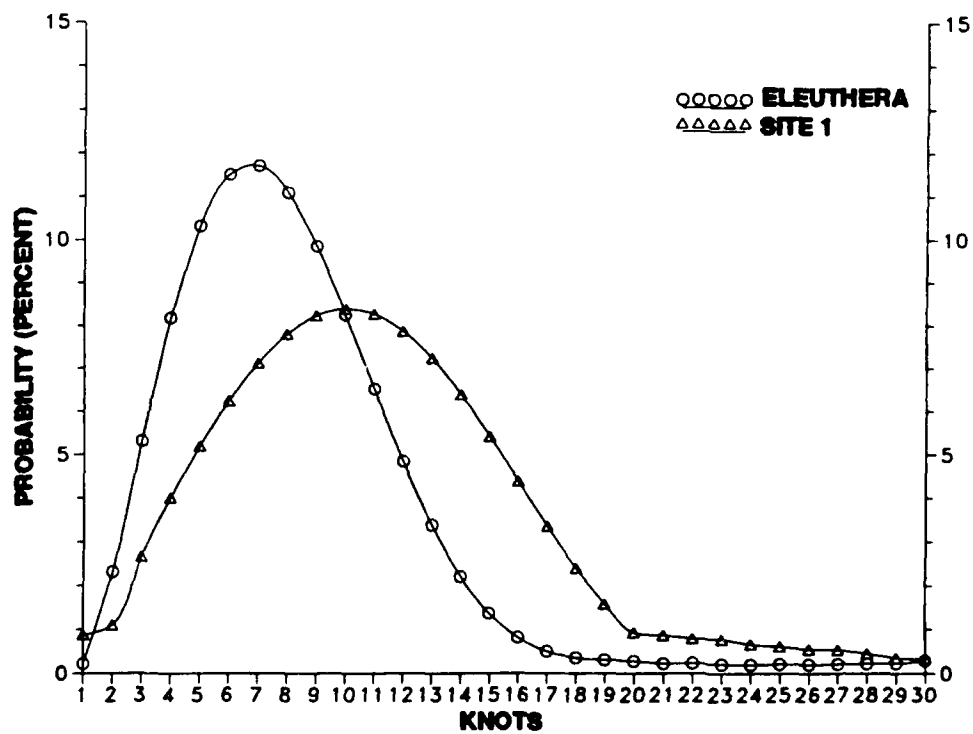


Figure 25. Eleuthera and Site 1 Speed Probability Density

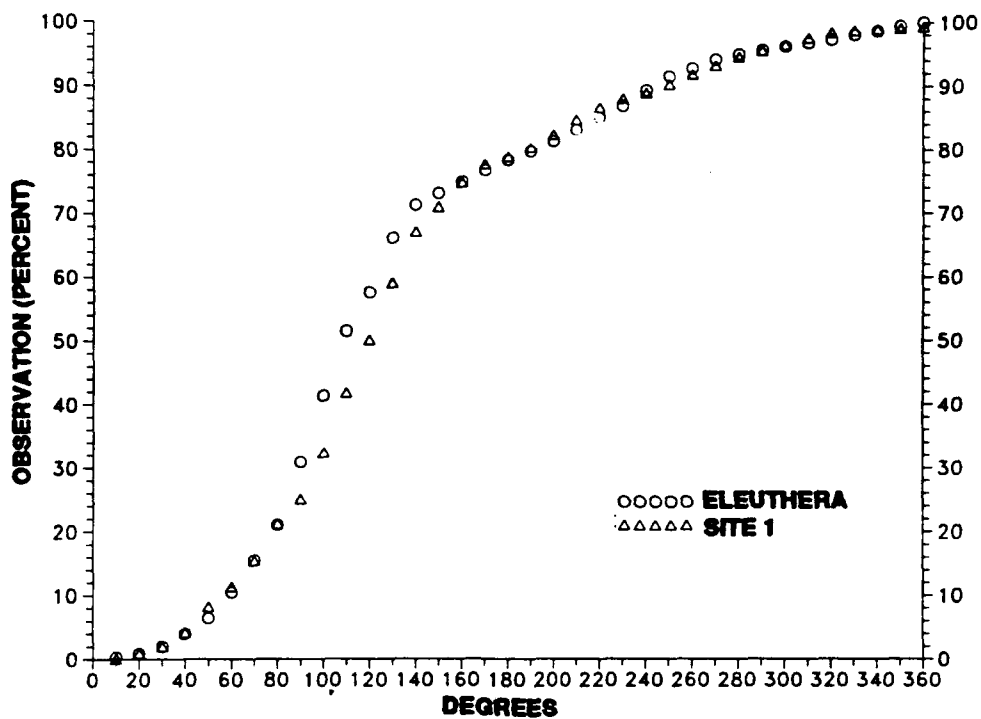


Figure 26. Eleuthera and Site 1 Direction Empirical Distribution

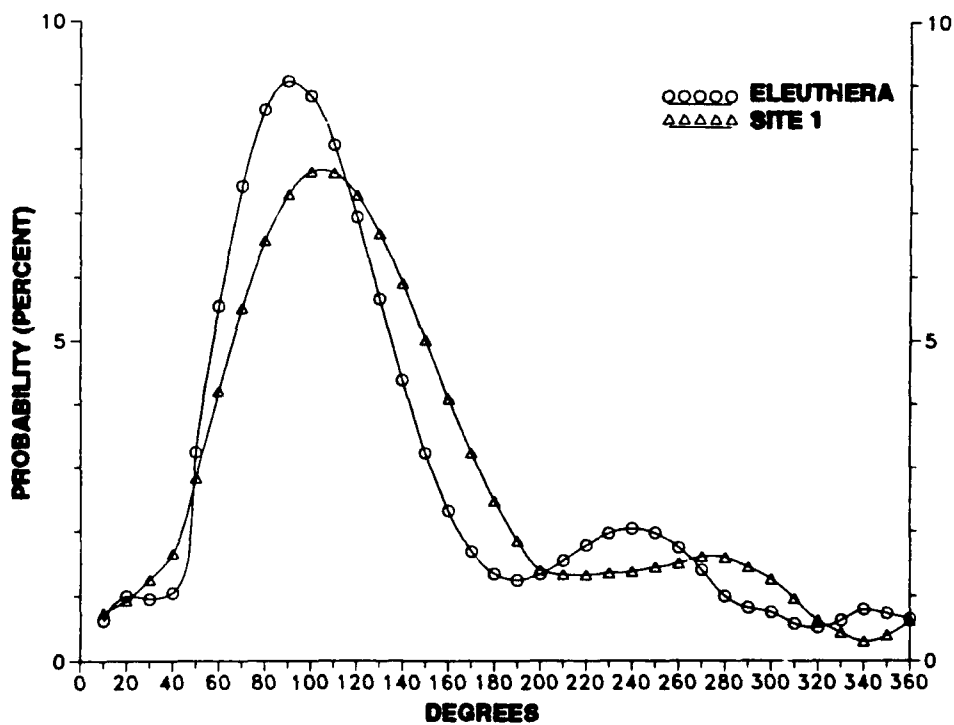


Figure 27. Eleuthera and Site 1 Direction Probability Density

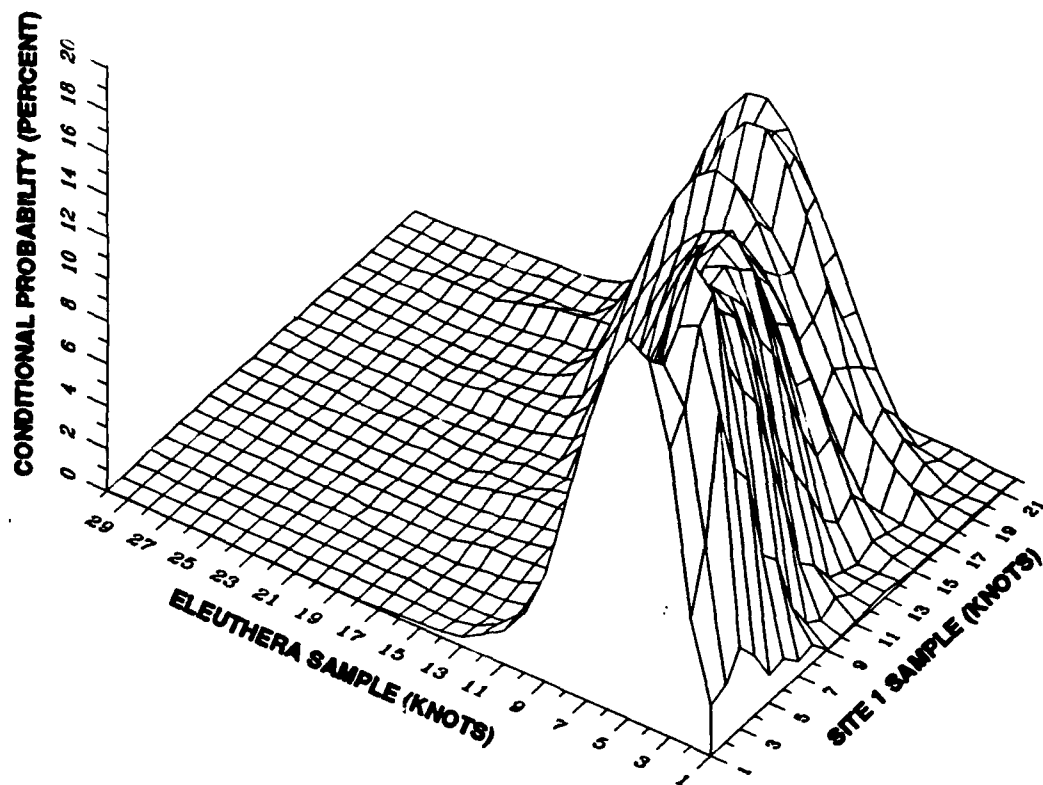


Figure 28. Eleuthera and Site 1 Speed Conditional Probability

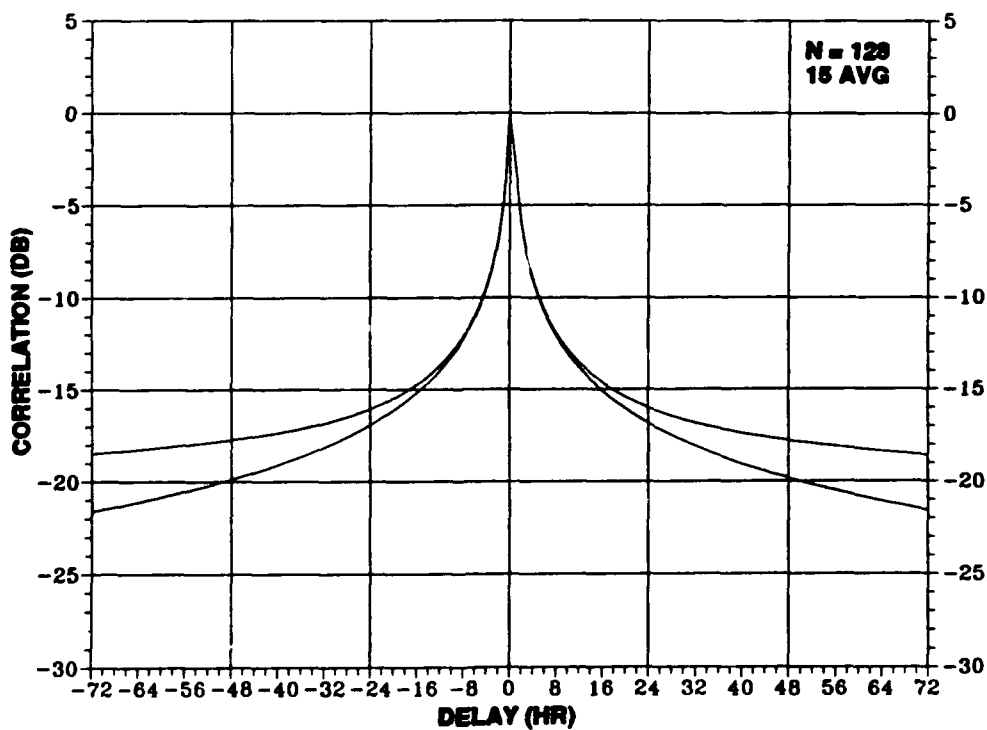


Figure 29. Eleuthera and Site 1 Crosscorrelation

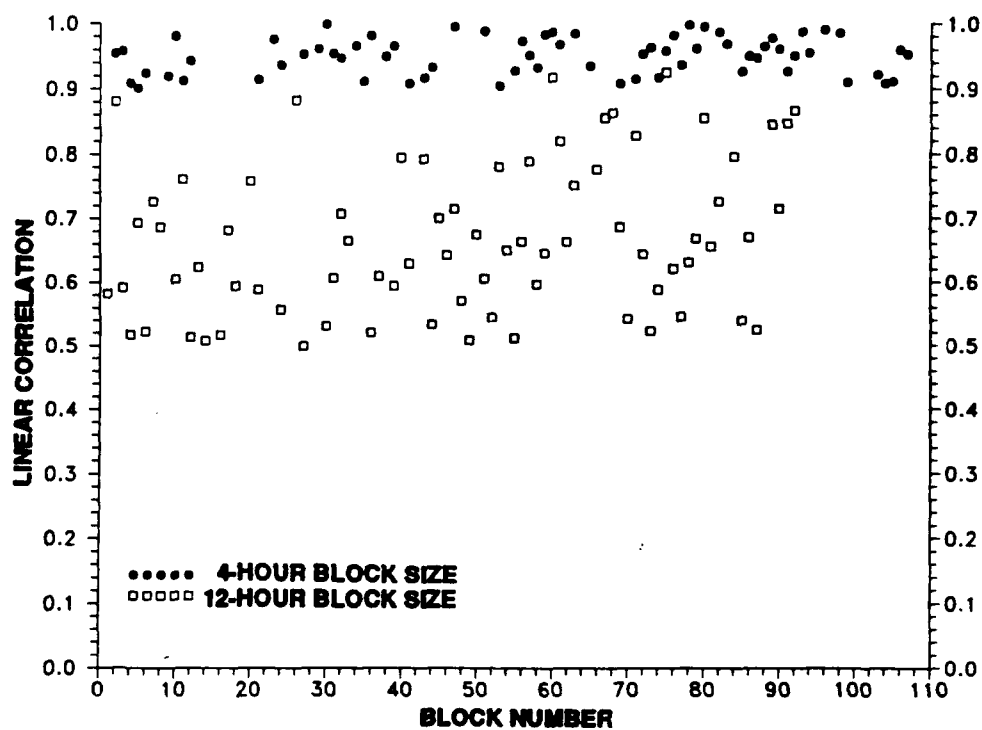


Figure 30. Eleuthera and Site 1 Average Speed Linear Correlation

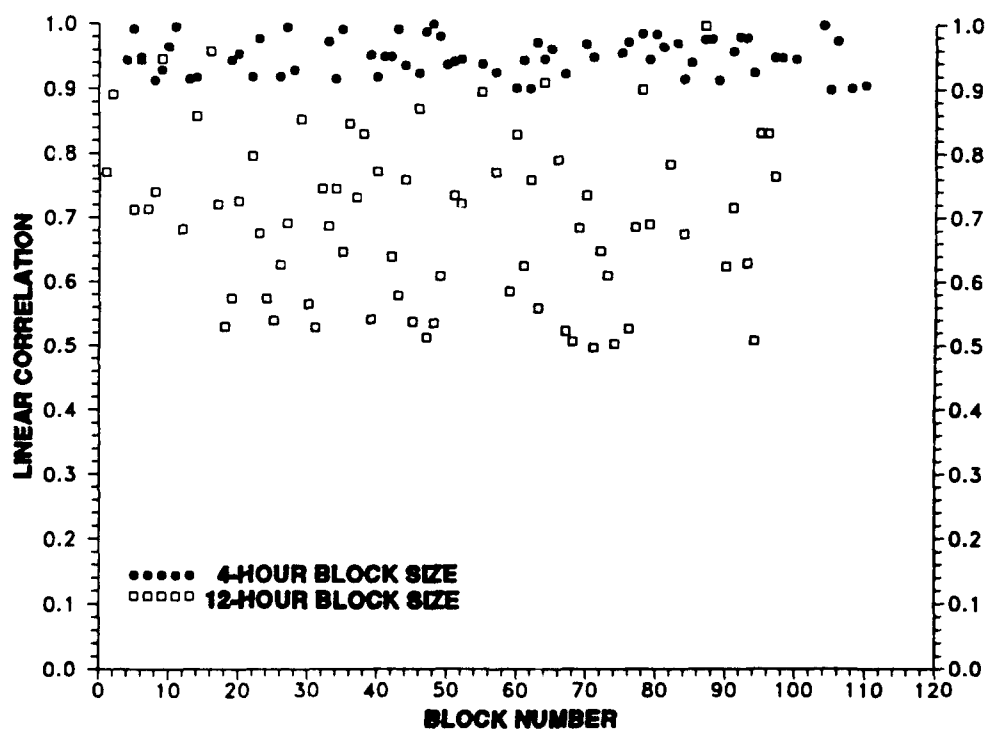


Figure 31. Eleuthera and Site 1 Direction Linear Correlation

2.5 SITE 1 VS ELEUTHERA DAILY AVERAGED WIND DATA

The daily averaged wind speed and deviations for Site 1 and Eleuthera are presented in figures 32 and 33, respectively. The Site 1 positive wind speed bias is clearly evident in figure 32.

2.6 SITE 1 VS ELEUTHERA PER HOUR WIND DATA

The per hour averages for the Site 1 and Eleuthera wind speed data are presented in figure 34. The distinctive diurnal pattern of nighttime lulls and daytime wind speed increases is evident for both data sets. The corresponding sample deviations per hour are shown in figure 35.

2.7 SITE 7 VS ELEUTHERA HOURLY AVERAGED WIND DATA

This section compares the appropriate AUTECH Site 7 data with the data collected at Eleuthera (reference 2).

2.7.1 *Probability Distribution and Density*

Figure 36 shows the empirical distribution functions for the Site 7 and Eleuthera hourly averaged wind speeds. This plot shows that the Site 7 wind speed data are, on average, higher than the Eleuthera wind speeds. In particular, the Site 7 median is about 12 knots, while the Eleuthera median is about 8 knots. Figure 37 plots the calculated probability densities for the Site 7 and Eleuthera hourly wind speeds. The Site 7 mode is 12 knots; the Eleuthera mode is 7 knots.

Empirical distribution functions for the Site 7 and Eleuthera wind direction data are shown in figure 38. Much closer agreement is seen here than for the wind speed data. Figure 39 plots the corresponding calculated probability densities; the east and east-southeast directions are seen to be the most probable.

2.7.2 *Conditional Probability*

The conditional probability of hourly averaged wind speed at Eleuthera (event B), given a wind speed observation at Site 7 (event A), is plotted in figure 40. Note the asymmetric distribution of wind speed predicted at Eleuthera; that is, for the higher wind speed observations at Site 7, the predicted Eleuthera speed is considerably lower than the value observed at Site 7. This result is in contrast to the Site 1 observations applied to the next hourly wind speed at Site 1 as was shown earlier in figure 11.

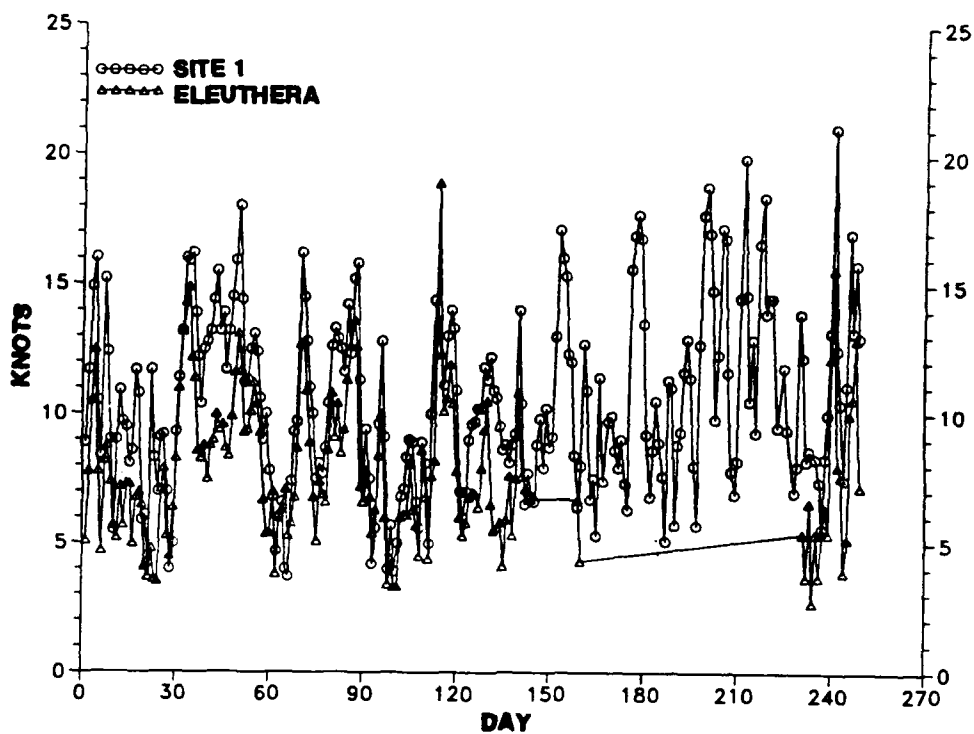


Figure 32. Eleuthera and Site 1 Daily Averaged Speed

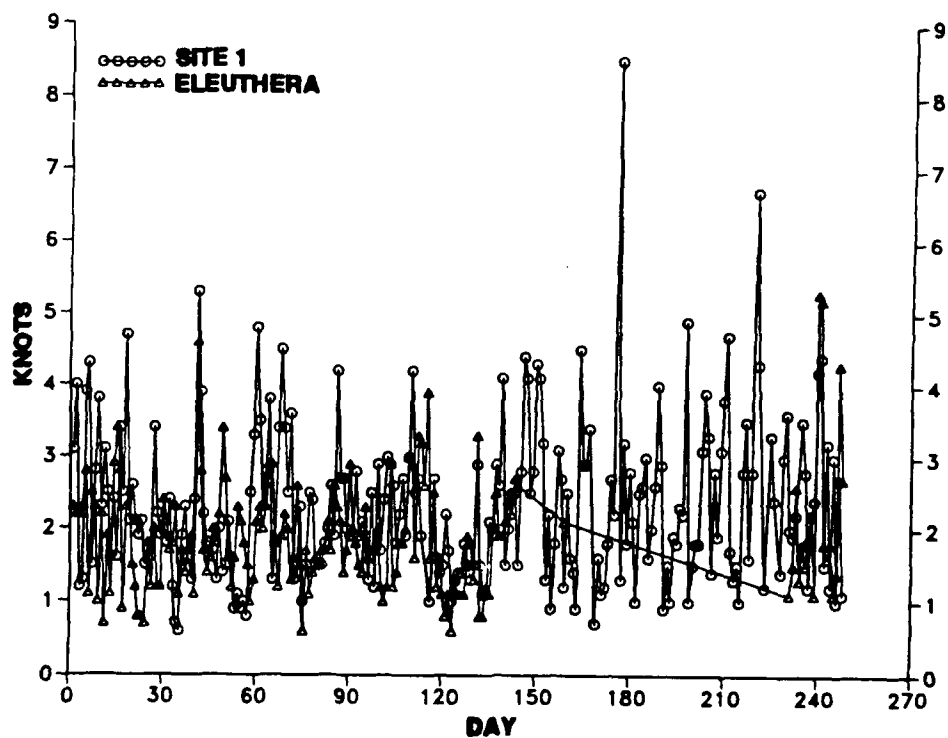


Figure 33. Eleuthera and Site 1 Daily Speed Deviation

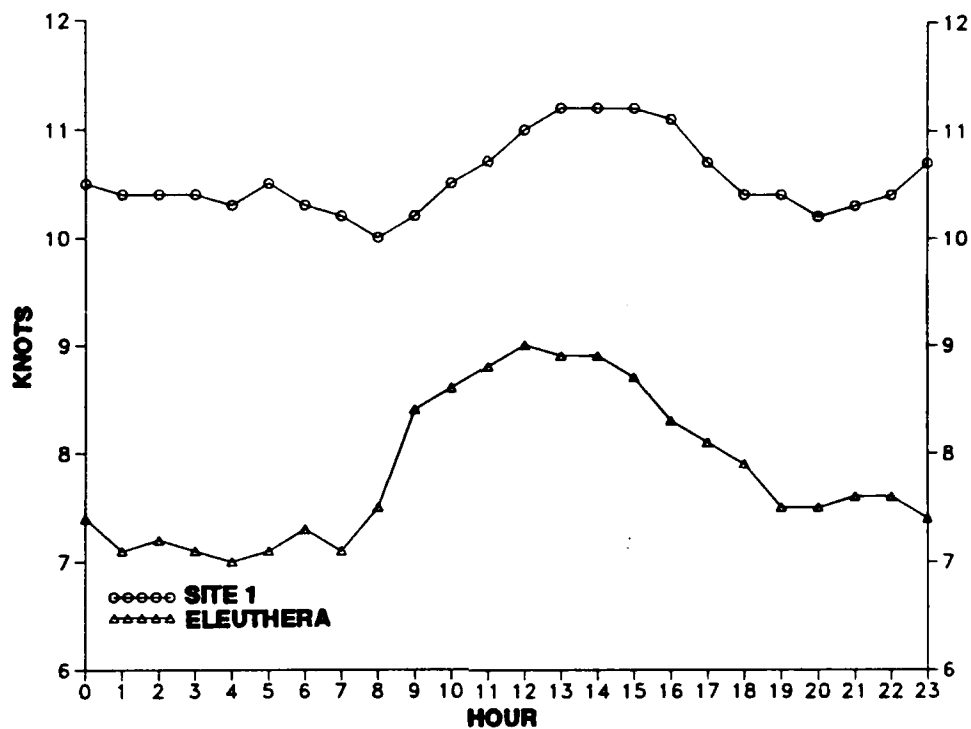


Figure 34. Eleuthera and Site 1 Hourly Averaged Speed

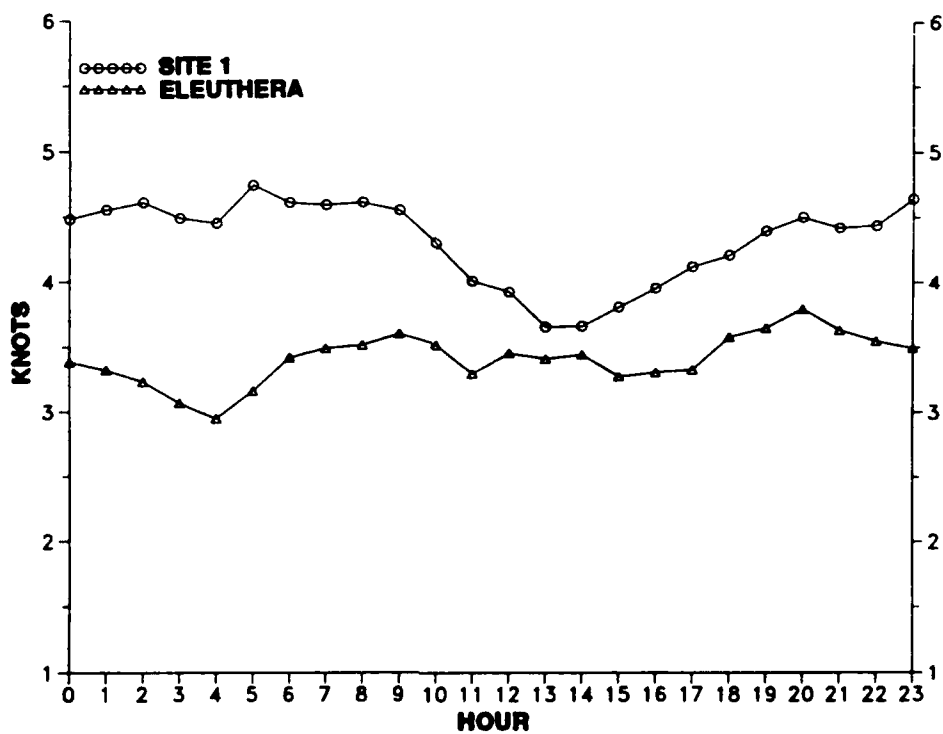


Figure 35. Eleuthera and Site 1 Hourly Speed Deviation

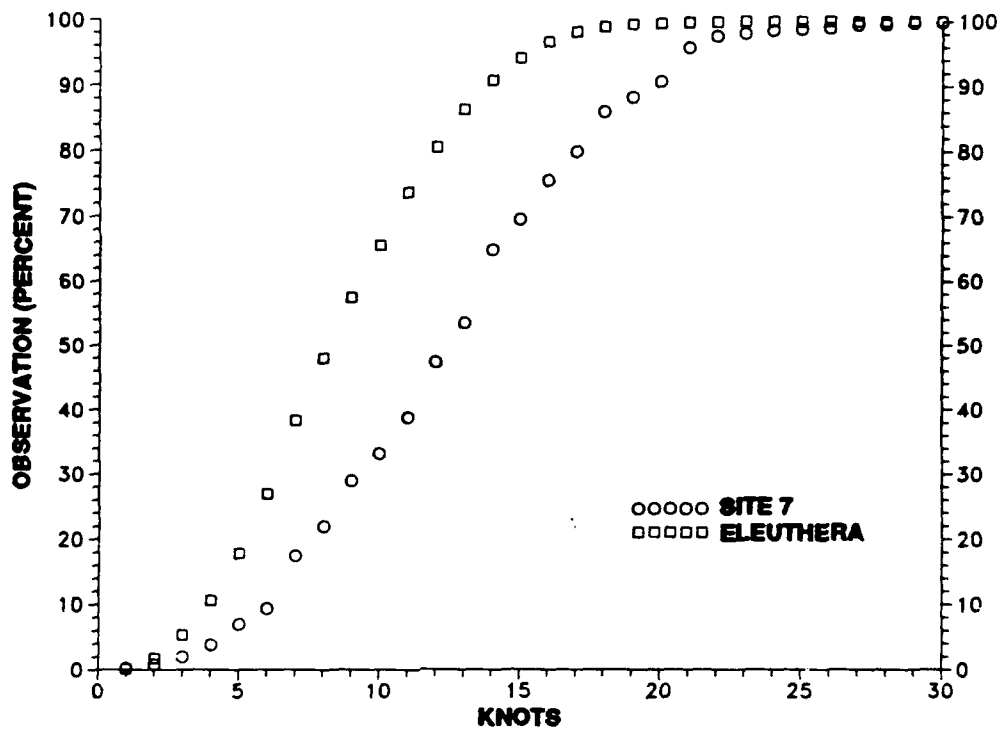


Figure 36. Eleuthera and Site 7 Speed Empirical Distribution

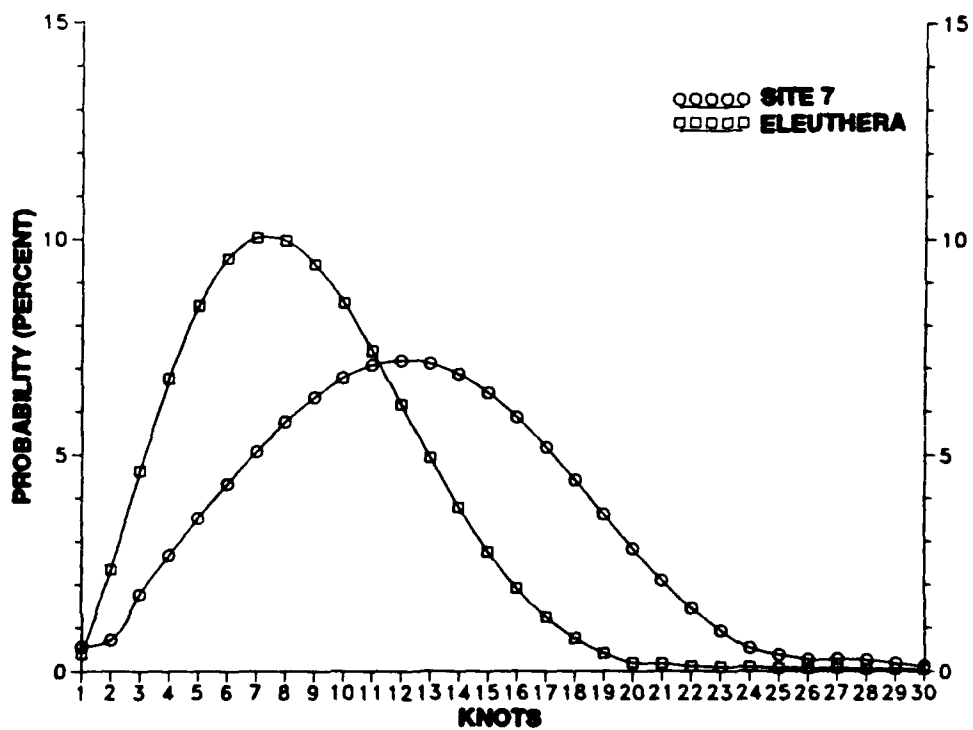


Figure 37. Eleuthera and Site 7 Speed Probability Density

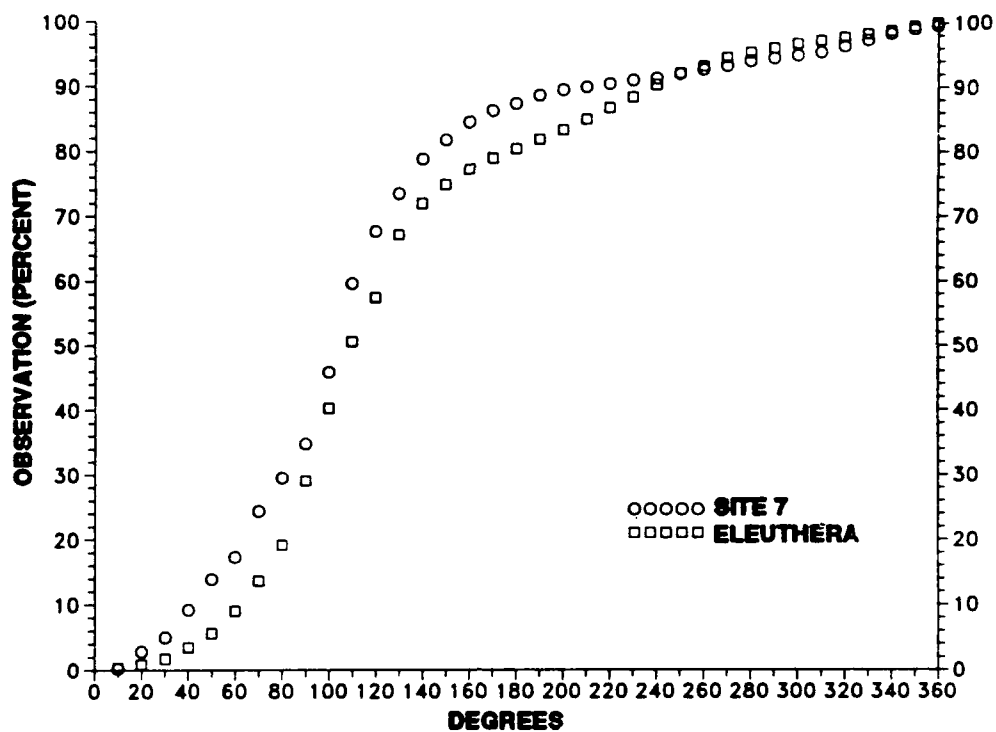


Figure 38. Eleuthera and Site 7 Direction Empirical Distribution

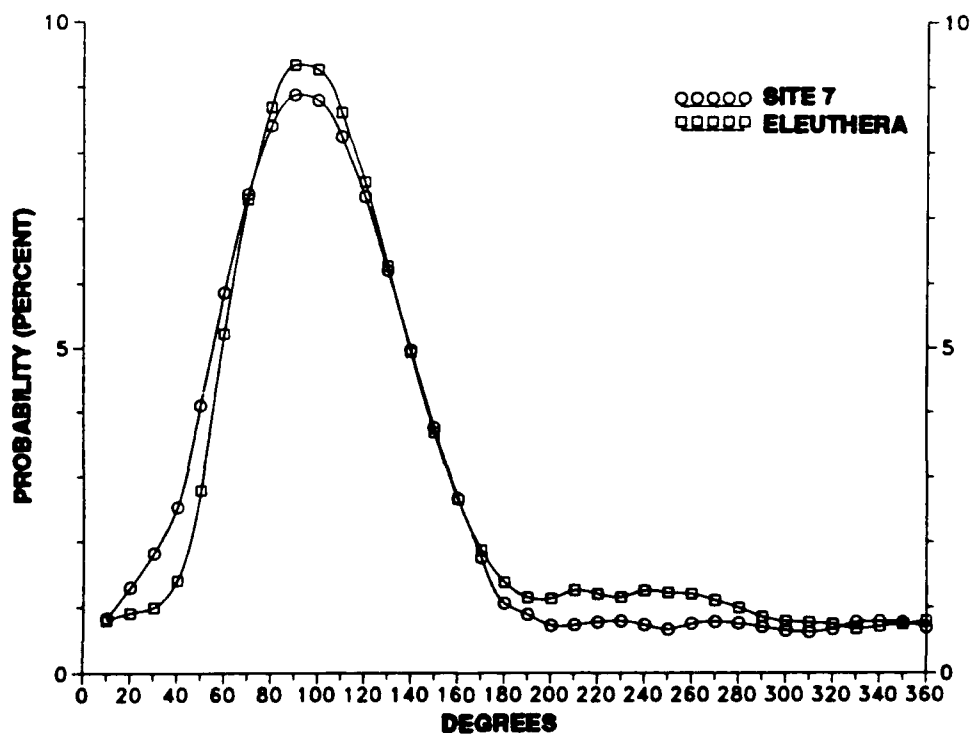


Figure 39. Eleuthera and Site 7 Direction Probability Density

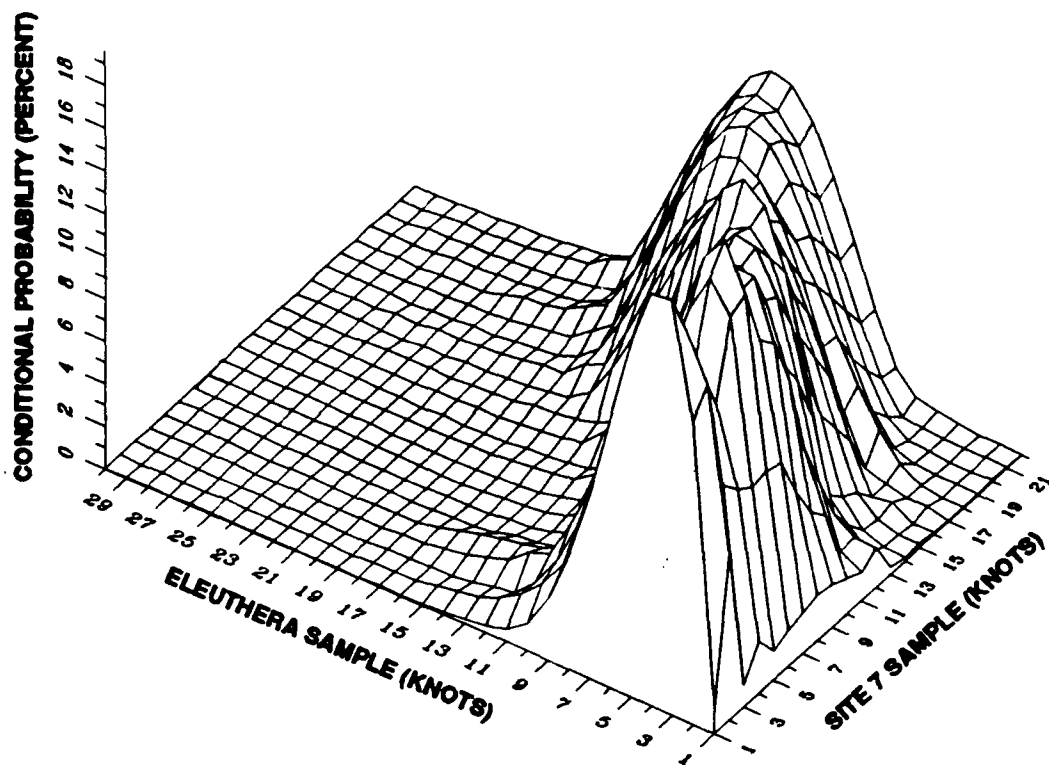


Figure 40. Eleuthera and Site 7 Speed Conditional Probability

2.7.3 Crosscorrelation

The crosscorrelation for the Site 7 and Eleuthera wind speed and direction data is shown in figure 41. The correlation is essentially identical to that for Site 1 vs Site 7 and Site 1 vs Eleuthera. It is seen that the temporal processes are well correlated for zero lag time.

2.7.4 Linear Correlation

Figures 42 and 43 present the linear correlation coefficients for the Site 7 and Eleuthera averaged wind speed and direction data, respectively. The calculations are shown for the 4-hour and 12-hour data blocks, with results similar to those obtained for the Site 1 vs Site 7 and Site 1 vs Eleuthera comparisons.

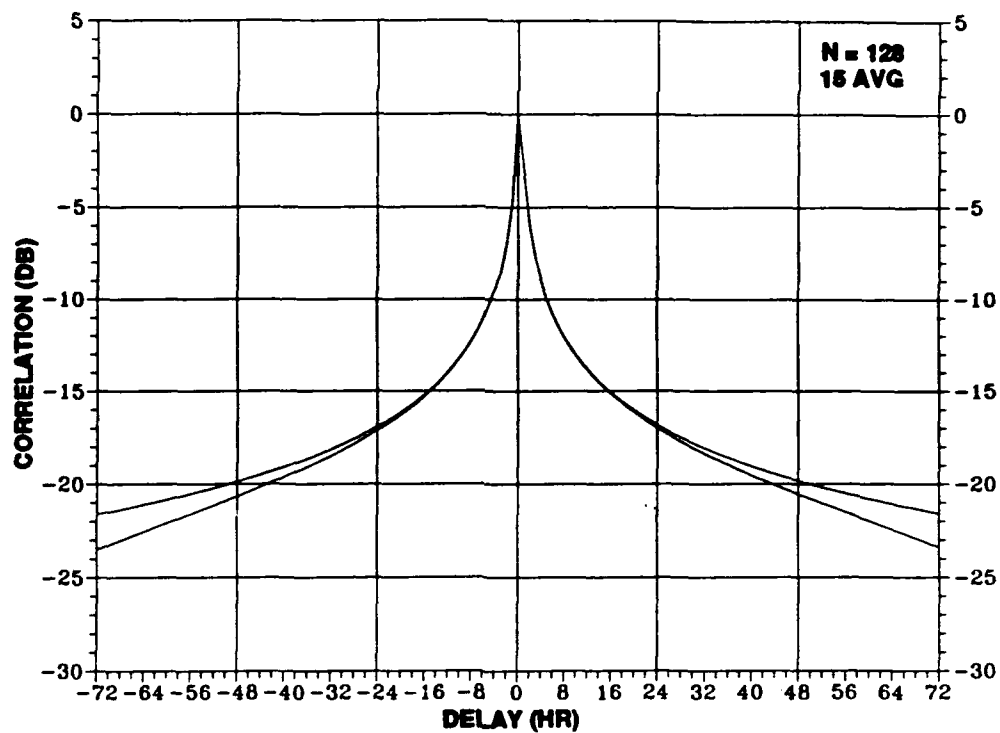


Figure 41. Eleuthera and Site 7 Speed Crosscorrelation

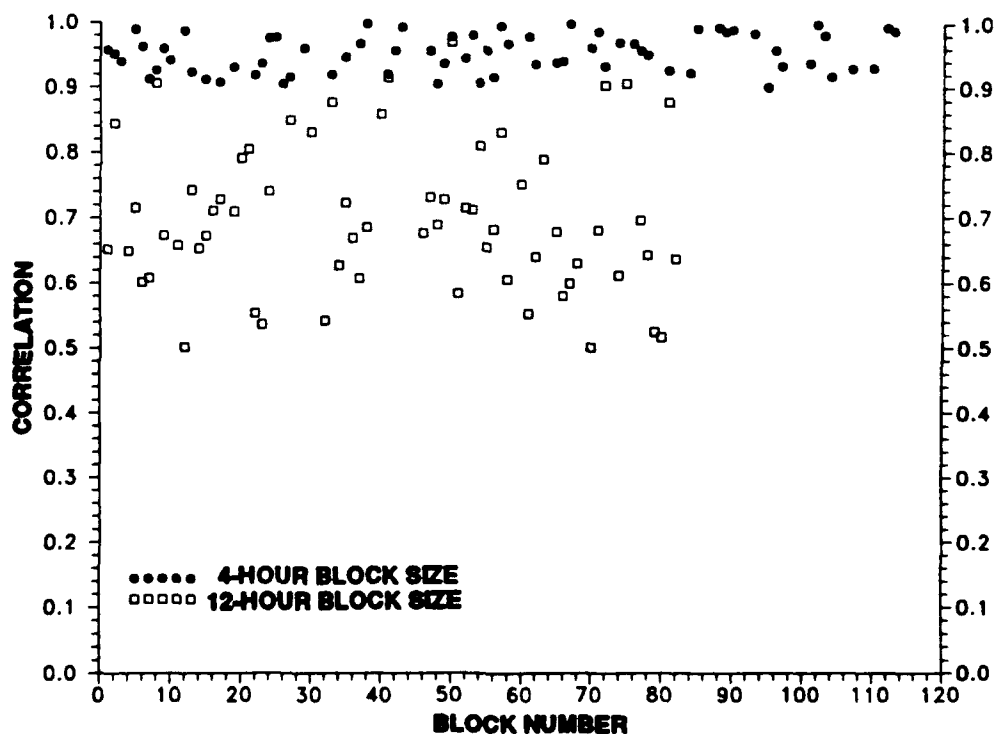


Figure 42. Eleuthera and Site 7 Speed Linear Correlation

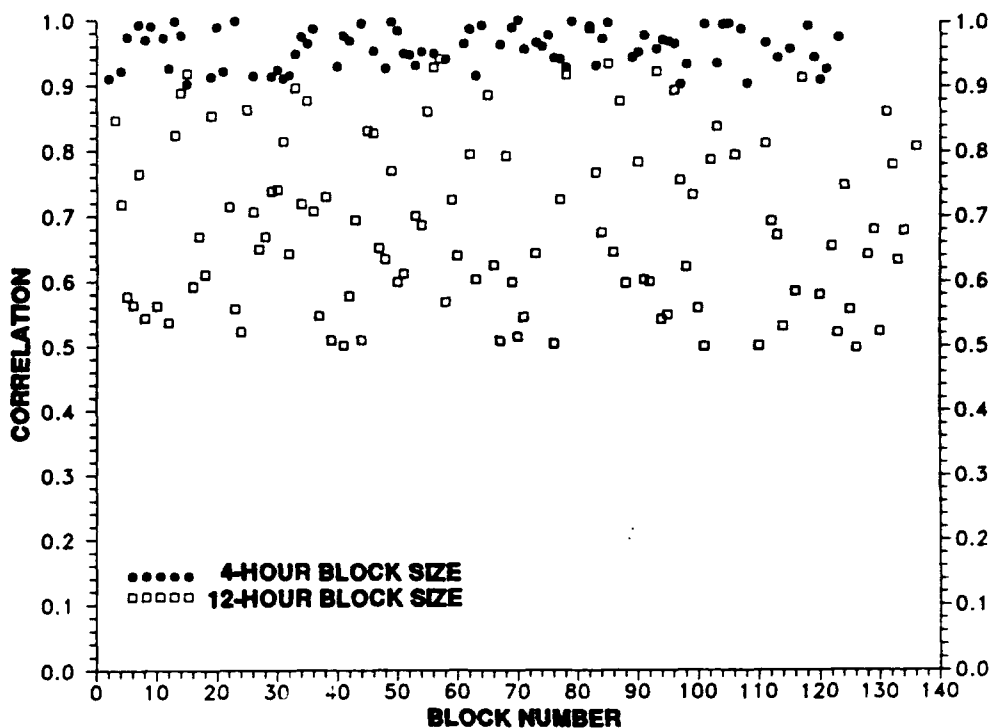


Figure 13 Eleuthera and Site 7 Direction Linear Correlation

2.8 SITE 7 VS ELEUTHERA DAILY AVERAGED WIND DATA

The daily averaged wind speed and deviations for Site 7 and Eleuthera are presented in figures 44 and 45, respectively.

2.9 SITE 7 VS ELEUTHERA PER HOUR WIND DATA

The per hour averages for Site 7 and Eleuthera wind speed data are presented in figure 46. The distinctive diurnal pattern common to the Eleuthera and Site 1 data is not seen in the Site 7 data. The corresponding sample deviations per hour are shown in figure 47.

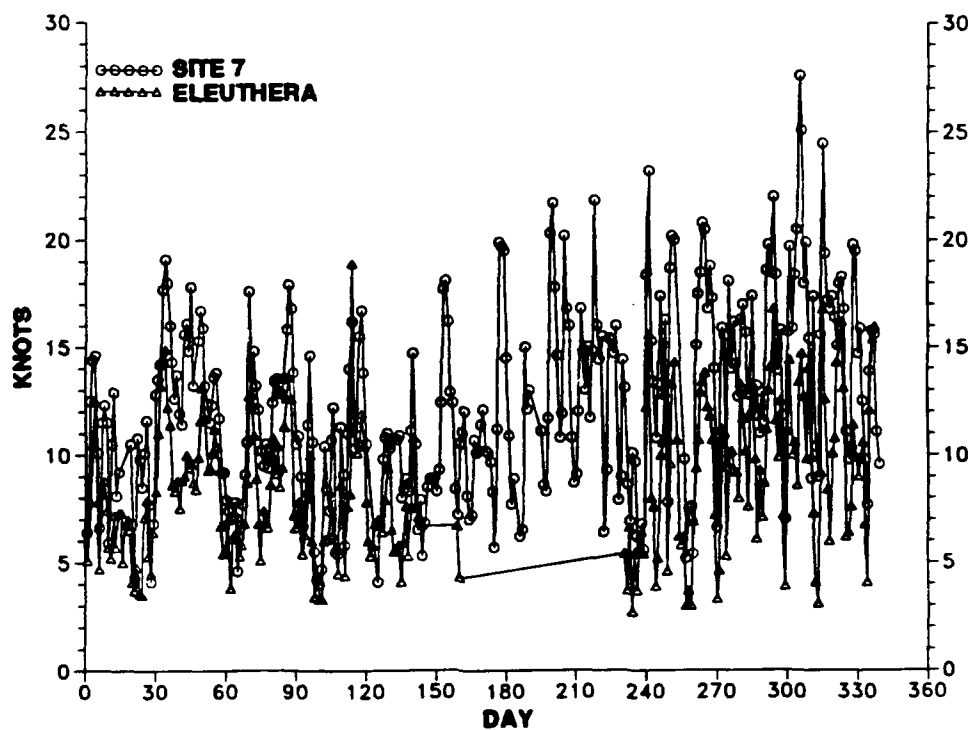


Figure 44. Eleuthera and Site 7 Daily Averaged Speed

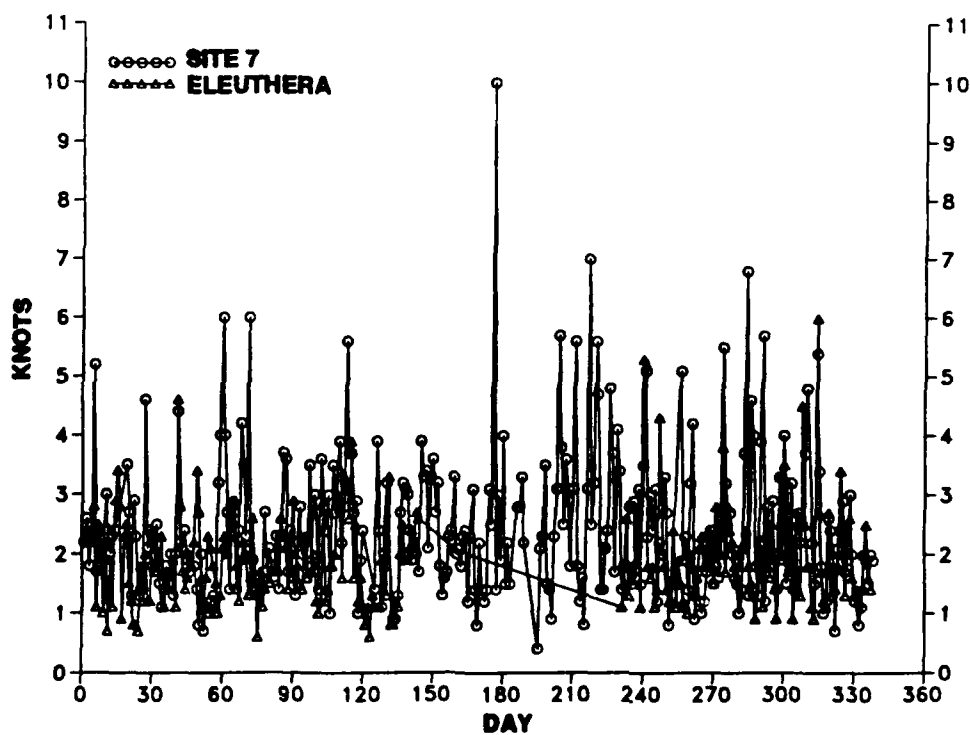


Figure 45. Eleuthera and Site 7 Daily Speed Deviation

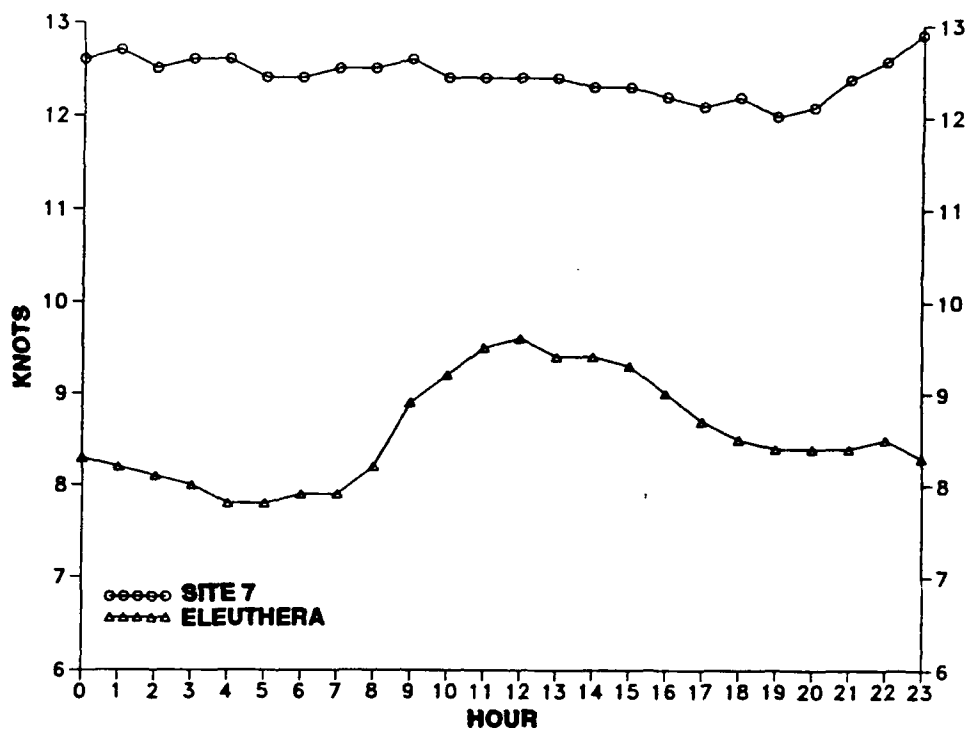


Figure 46. Eleuthera and Site 7 Hourly Averaged Speed



Figure 47. Eleuthera and Site 7 Hourly Speed Deviation

3. CONCLUSIONS

A statistical comparison of hourly averaged wind data at AUTECH Site 1 and Site 7 has shown the two data sets to be similar. The overall calculated probability densities for wind speed from Sites 1 and 7 (figure 8) show that the Site 7 data have a 1-knot positive bias relative to the Site 1 data. The crosscorrelation (figure 14) produced a singular peak at zero lag time, indicating that the real-time concurrent Site 1 and Site 7 hourly averaged wind data are well correlated. Linear correlation coefficient calculations based on 4-hour data blocks yielded values between 0.9 and 1. A linear systems frequency analysis found the coherence to be too low to provide a useful transfer function relation for all but the near-dc frequency components.

Comparison of the AUTECH and Eleuthera data indicated a larger positive bias for the AUTECH sites relative to Eleuthera than was found for the Site 1 to Site 7 comparison. The calculated probability densities (figures 25 and 37) show a difference in mode of 3 knots (for Eleuthera vs Site 1) and 4 knots (Eleuthera vs Site 7); these plots also show that AUTECH has a higher probability than Eleuthera of winds above 10 knots. While the data exhibit a significant bias, the correlation analysis showed the data to be well correlated at zero lag time and found correlation coefficients of 0.9 to 1 for 4-hour data blocks. A conditional probability density was developed to provide a predictive basis for Eleuthera winds based on AUTECH observations (figures 28 and 40); the conditional probabilities (figures 28 and 40) illustrate a reduction in wind speed predicted for the Eleuthera data based on AUTECH observations.

The finding of good data correlation between the two AUTECH sites (which are about 55 nmi apart) and between the AUTECH sites and Eleuthera Island (100 nmi from Site 1, 115 nmi from Site 7) is not surprising considering the surface geographic isotropy over the region. The major question raised by this analysis is: What is the origin of the biases found between the data bases? To answer this question, detailed data collection at the AUTECH and Eleuthera sites using identically installed and calibrated sensors would be required.

REFERENCES

1. H. C. Velez, "Wind and Barometric Pressure in the TOTO, Bahamas: A Summary of 1989 Observations," NUSC Technical Document 6978, Naval Underwater Systems Center, Newport, RI, 4 January 1991. *[Available to authorized requesters only]*
2. J. C. Park and J. J. Hinkamp, "A Statistical Analysis of Eleuthera Island Wind Data for the Period 27 April 1989 Through 30 March 1990," NUSC Technical Document 7016, Naval Underwater Systems Center, Newport, RI, 1 July 1991.

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